

SCIENTIFIC REPORTS

OF THE

Agricultural Research Institute, Pusa

*(Including the Reports of the Imperial Dairy Expert,
Physiological Chemist, Government Sugarcane Expert,
and Secretary, Sugar Bureau)*

1925-26



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Scientific Reports of the Agricultural Research Institute, Pusa

(Including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau.)

1925-26

REPORT OF THE DIRECTOR.

(W. H. HARRISON, D.Sc.; and W. McRAE, M.A., D.Sc., F.L.S.)

I. CHARGE AND STAFF.

Charge. The post of Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa, was held until 2nd May, 1926, by Dr. D. Clouston, C.I.E., who, on being placed on special duty as Liaison Officer between the Royal Commission on Agriculture and the Government of India and the Local Governments, handed over to Dr. W. H. Harrison.

Mr. G. S. Henderson officiated as Joint Director up to 3rd November, 1925, when Dr. W. H. Harrison returned from leave. Since the appointment of the latter as Agricultural Adviser, Dr. W. McRae has been officiating in the post of Joint Director.

Staff. On return from leave on 4th November, 1925, Dr. W. H. Harrison resumed the office of Imperial Agricultural Chemist from Dr. J. Sen, but from the date on which he relieved Dr. Clouston, Mr. J. N. Mukerji has been placed in charge of the current duties of the post.

Mr. G. S. Henderson having proceeded on leave for seven months from 16th March, 1926, Mr. Arjan Singh Man was placed in charge of the current duties of the office of Imperial Agriculturist.

Mr. M. Mitra continued to be in charge of the current duties of Imperial Mycologist until 22nd November, 1925, when Dr. W. McRae returned from leave.

Dr. F. J. F. Shaw held the post of Imperial Economic Botanist throughout the year except for a period of 24 days from 8th May, 1926, when he was on leave and Mr. Kashi Ram was in charge of the current duties of the Botanical Section.

Mr. J. H. Walton has been appointed Imperial Agricultural Bacteriologist from 20th April, 1926, the date on which Mr. C. M. Hutchinson proceeded on leave for nine days, preparatory to retirement.

Mr. M. Afzal Husain officiated as Imperial Entomologist throughout the year, the permanent incumbent, Mr. T. Bainbrigge Fletcher, being away on leave.

The current duties of the Secretary, Sugar Bureau, have been placed in charge of Rao Saheb Kasanji D. Naik during the absence of Mr. M. Wynne Sayer on leave for $6\frac{1}{2}$ months from 25th March, 1926.

On the expiry of leave for three months from 4th November, 1925, Dr. J. Sen, Supernumerary Agricultural Chemist, was transferred to the Forest Research Institute, Dehra Dun, for appointment as Bio-Chemist for two years.

Mr. P. V. Isaac, Second Entomologist (Dipterist), was on leave for 1 month and 29 days from 2nd September, 1925, and again proceeded on leave for $6\frac{1}{2}$ months from 26th March, 1926.

The two posts of Physical Chemist and Agronomist were filled during the year by the appointment of Dr. A. N. Puri from 3rd May and of Mr. A. M. Mustafa from 22nd June, 1926, respectively.

II. RESEARCH.

The research work done by the Institute aims at establishing principles which can be put into general practice by provincial

agencies. The more important work of the year under report is summarized below :—

Botanical Section. Large-scale tests, both on Government farms and private estates, in Bihar, United Provinces and Central Provinces, have fulfilled the promise held out by the bearded wheat hybrid Pusa 52 during the preliminary trials of last year. This wheat has consequently been adopted for seed distribution by the Department of Agriculture in Bihar and Orissa. Another promising new wheat variety is Pusa 80-5 which has given equally high yields in the Punjab, United Provinces and Bihar. Further trials with the American tobaccos Adcock and Burley have shown that these exotics can be grown successfully in Bihar, and that it may be possible to produce a bright cigarette tobacco with the curing methods devised. The first batch of sugarcane seedlings obtained from Coimbatore have grown well and will yield ample material for trials on a larger scale. Observations made on loquat trees in the Botanical Area have indicated that both Pale Yellow and Golden Yellow varieties are self-sterile, and that one will only set fruit when pollinated from the other. Oats, barley, maize, gram, linseed, safflower, sesamum, peas, *mung* (*Phaseolus mungo*), *urid* (*P. radiatus*), *masur* (*Lens esculenta*), pigeon-pea and chillies are other important crops which are being investigated for isolation of types, in order to choose those superior, both in yield and agricultural characters, to the mixtures at present grown.

Chemical Section. A further study of the movements of nitrates in the soil and the subsoil, which was carried out in four areas treated as pasture, fallow, unirrigated cropped land, and cultivated land receiving irrigation, has confirmed the previous year's conclusion that the distribution of nitrates in the soil, besides being regulated by rainfall and the physical character of the subsoil layers, is profoundly modified by the growth of crops and cultural operations. It also appears that very considerable quantities of nitrates are washed into the subsoil and ultimately lost, and that there is only a very restricted upward movement of these subsoil nitrates. A non-calcareous soil has been found to improve in fertility by

the addition of about 5 per cent. of chalk to supply the lime deficiency along with a further quantity of either chalk or sand to improve its physical condition, provided the excess is not large. The investigation into the relation of the clay content of soils to their moisture absorption has reached a stage at which preliminary results can be published. Experiments carried out during the year indicate that a hard light-coloured *gur* which will not absorb moisture and will not turn black in course of time, can be obtained by employing a preliminary treatment using a slight excess of lime followed subsequently by the addition of a quantity of phosphoric acid barely sufficient to precipitate the excess lime. The detection of foreign fats in adulterated butter fat or *ghee* is the subject of another investigation in progress. Of the several solvents tried, acetic ether has been found most promising. With the appointment of a Physical Chemist on the staff of the Section, it will now be possible to investigate a class of soil problems which hitherto have not received that attention which their importance warrants.

Bacteriological Section. Estimations of total nitrogen to a depth of one foot and of nitrates to a depth of three feet in four fallow plots, two of which got a dressing of farmyard manure, during a period of three years, point to the conclusion that, under certain conditions, nitrogen-fixing bacteria become very active, adding to the soil large quantities of nitrogen which is, however, easily lost unless conditions are such that it is nitrified and taken up by a growing crop. The decomposition of a compost of mustard cake is hastened if a quantity of charcoal equal to 5 per cent. of the weight of cake is added. Not only is the efficiency of the resultant manure increased, but the objectionable odour of the fermented cake is considerably modified. Similarly when 6 per cent. of charcoal is added to a bonemeal-sulphur-sand compost, the solubilization of phosphoric acid is more efficient and proceeds for a longer time. Further experiments with different leguminous plants have confirmed the conclusion previously arrived at, that higher yields are obtained by green-manuring with only the leafy portions than with whole plants. Among other items of

interest may be mentioned the discovery of a bacillus which when grown with any one of certain organisms decomposes cellulose, and the study of the bacterial flora of silage.

Mycological Section. Further progress has been made in elucidating the factors affecting the pigeon-pea wilt problem and in interpreting the data obtained from the existing field experiments. It appears that green-manure does not always reduce the wilt in a plot manured with superphosphate; that under farm conditions the infection is spread mechanically through the soil in an irregular manner; that the great bulk of infection comes from the fungus in the soil and not from spores borne on the seed; and that though the amount of moisture in the soil has no direct relationship to the amount of wilt, the retentive nature of the soil increases the incidence. Work is also proceeding, in collaboration with the Imperial Economic Botanist, towards the isolation of a race of pigeon-pea which will prove resistant to wilt. A survey of the sugarcane growing stations in different parts of India has revealed the presence of mosaic disease among such popular canes as Red Mauritius, Purple Mauritius, Hemja, and Fiji B., as well as a few of the Coimbatore seedlings. Three varieties have been planted at Pusa for regular roguing to test the possibility of eradication of the disease. The study of fruit rot disease of various Cucurbitaceæ caused by a species of *Pythium* has been concluded, and it has also been definitely ascertained that the fungus responsible for deaths among young berseem plants is *Rhizoctonia Solani*. The temperature relationship of cotton wilt fungus, the wilt diseases of linseed and gram, and the smut disease of mustard are subjects of other investigations in progress.

Entomological Section. The use of sticky bands proved a very cheap and most efficacious method of dealing with *Monophlebus* sp. which is a pest of fruit trees and is also a serious nuisance when it invades dwellings. Aphids infesting a plot of lentils were destroyed by liberating therein adults of *Chilomenes sexamaculata*, while *Brachytypes portentosus* was successfully controlled in a field of sugarcane by pouring petrol in their burrows. Calcium cyanide was demonstrated

to be the most effective chemical among various insecticides used in spraying and dusting experiments against mango-hoppers. Investigations have been put in hand to determine the influence of cultural operations on the pest resisting powers of plants, and also to test the lethal effects of carbon bisulphide on *Bruchus chinensis*, a serious pest of stored grain, under varying conditions of temperature, humidity and duration of exposure. Work on the life-histories and distribution of Tabanidæ was continued, and the possible transmission of rinderpest through the agency of the tick *Boophilus australis* was investigated in collaboration with the Director of the Muktesar Institute.

Agricultural Section. The permanent experiments being carried out in collaboration with other Sections of the Institute, were continued. With a view to developing the above line of work, an Agronomist has been appointed to the Section. The non-experimental area forms a demonstration in mixed farming on a large scale treated in a manner to secure the maintenance of soil fertility and a regular supply of green fodder for the dairy herd. With the reclamation of 130 acres of low-lying land, on which two crops of berseem and early maize are raised by irrigation, plenty of green fodder is available throughout the year for the whole herd, both for grazing and for feeding in the byre. The abundance of luscious green food has been reflected in the increase of 1.1 lb. in the average yield per cow per day, which now stands at 15.5 lb. In the pure Sahiwal herd of 78 cows, 35 have given over 4,000 lb. of milk per lactation of 300 days, and of these four yielded over 6,000 lb. and eight over 5,000 lb. Among the half-bred Ayrshire-Sahiwal herd of 40 cows, of which the average yield is 20 lb., there are 16 cows which have given over 6,000 lb. Having produced a cross of good milking capacity by adding Ayrshire blood, the present policy is to adapt that strain to the needs of the country by mating the cross-bred dams with Sahiwal bulls of good milch pedigree.

Imperial Dairy Expert. In accordance with the cross-breeding policy adopted at Pusa, all cows having European blood on the Bangalore and Wellington farms are now sired

by Indian bulls of good milch pedigree. At Karnal, pure herds of Thar Parkar and Haryana cattle and Murra buffaloes are being developed. The creamery at Anand acquired during the year is being used for the manufacture of butter on a factory scale. All these institutions, though largely utilized for training purposes, are being run on quasi-commercial lines. The Imperial Dairy Expert continued to co-operate with Provincial Agricultural Departments and city municipal corporations in the matter of giving advice and assistance in technical matters connected with the dairying and cattle-breeding industry.

Physiological Chemist. Experiments on the nutrition of growing animals indicate that the total amount of organic matter digested and the percentage digestion are very important measures of the actual value of a ration, and that the proportion of protein may vary within wide limits without influencing the rate of growth. Results of great significance were obtained in experiments with some Indian coarse foodstuffs. Of the four roughages, *viz.*, hay, rice-straw, sorghum-straw and wheat-straw, fed to calves at Karnal, rice-straw gave the highest live-weight increase, a result contrary to local opinion which holds that wheat-straw is preferable. In digestion experiments at Bangalore rice-straw was found to have decidedly a higher net energy value than that assigned to the American product. It was incidentally noticed that, due to its high potash content, rice-straw produces persistent diuresis. At Hosur, while eight cattle fed on silage showed an average increase of 29 lb. at the end of 13 weeks, each of the eight animals receiving hay lost 3 lb. The silage is probably not more nutritious but is eaten more readily and in amounts above the maintenance requirement. The experiment has proved the advantage of converting spear grass into silage.

Imperial Sugarcane Station. A Second Cane-breeding Officer has been appointed on the staff of the station mainly for the purpose of breeding thick types of sugarcane for Peninsular India, Assam and Burma, and the farm area has been extended by the acquisition of an additional $38\frac{1}{2}$ acres. The breeding of thin varieties for Northern India was continued,

and over 20,000 plants of the F_3 generation were raised during the year. Nearly 1,300 seedlings of the same parentage as the well-known Co. 205 have been obtained in the hope that some of them, while possessing all its good points, might mature earlier and yield less impure juice. An appreciable advance in the technique of cane-breeding has been effected by the successful isolation of live cane arrows away from the reach of adventitious pollen.

Sugar Bureau. The Bureau continued to test new seedlings from Coimbatore with a view to ascertaining which of them can usefully supplant Co. 210, Co. 213 and Co. 214 which have already entered into general cultivation in Bihar and the adjoining districts of the United Provinces. Of the new arrivals, Co. 205 has been found suitable for low-lying lands, Co. 275 and Co. 280 have been selected for growing on a field scale for mill trials, and Co. 290 has proved most promising in preliminary tests. The Bureau also laid down experiments during the year to test the value of different fertilizers and different methods of sowing cane, as well as to ascertain whether cane can be sown with advantage in October instead of in February as is the usual practice in North Bihar. In future all agricultural operations in connection with the growing and testing of canes at Pusa will be carried out by the Agricultural Section, the Secretary of the Bureau remaining in charge of the work of extending the area under selected canes. The sugar cable service conducted by the Bureau on a self-supporting basis continues to be appreciated by those who subscribe to it.

III. TRAINING.

Agricultural Research Institute, Pusa. The two-year post-graduate course started on 1st November, 1924, was completed during the year by Mr. Nand Lall Dutt, M.Sc., and Mr. S. Mukerji, M.Sc., in Botany and Entomology respectively. The former, on the completion of his training, received the appointment of Second Cane-breeding Officer at the Imperial Sugarcane Station, Coimbatore.

There were 28 candidates for admission to the new courses which began on 1st November, 1926. Of the six chosen by the Selection Committee, as possessing the necessary qualifications, one admitted to the Entomology course soon left on receipt of an offer of appointment in the Indian Museum, Calcutta. The remaining five (one each for Agricultural Chemistry, Agricultural Bacteriology and Mycology, and two for Botany), together with three admitted in the previous year (one each for Agricultural Chemistry, Botany and Mycology) and one scholar deputed by the Punjab Government for the Mycology course, were under training at the close of the year. The two post-graduate students of the Imperial Institute of Animal Husbandry and Dairying were given short courses at Pusa in estate management, cattle-breeding, plant-breeding, plant diseases, etc., during the last three months of their period of training.

Imperial Institute of Animal Husbandry and Dairying, Bangalore. The post-graduate course in animal husbandry and dairying started on 2nd January 1925, was completed by two students during the year under report. There were six applications for admission during the third session, of which one was selected.

The first batch of students under training for the Indian Dairy Diploma completed their two-year course in December 1925. Of the 12 candidates appearing at the examination, nine qualified for the Diploma, two passing with honours. Fifteen students of the Allahabad Agricultural Institute also presented themselves for the examination, of whom seven were declared successful. Twenty-three students from 69 applications have been enrolled for the new course which began at Bangalore in January 1926.

A special class of 22 officers of the Co-operative Departments of the Punjab, United Provinces, Bengal, Bombay, Baroda State and Cochin State was also held for a three-month course in co-operative dairying. In addition to these, 16 short-course students from different provinces, and 24 veterinary assistants deputed by the Punjab Government received techni-

cal instruction in cattle-breeding and dairying at Bangalore and Karnal.

IV. PUBLICATIONS.

Eighteen memoirs, seven bulletins and nine other publications were issued during the year, while 13 publications were in the press on 30th June, 1926. The publications issued dealt with subjects of general importance such as nitrogen recuperation in the soils of Bombay, determination of available phosphoric acid in calcareous soils, curing of tobacco, chemistry of silage, nutrients required for milk production with Indian foodstuffs, grasses and grass lands of Bombay, the Wagad cotton of Gujarat, control of the red pumpkin beetle, transmission of rinderpest by means of insects, nasal granuloma in cattle, bacteriology of milk, bot flies of the Punjab, prevention of loss of sugar by inversion in factories, standard methods of analysis of fertilizers, etc.

“The Agricultural Journal of India,” which is issued every two months, continues to maintain its popularity among the class of readers for which it is intended.

V. GENERAL ADMINISTRATION.

Buildings. Schemes for concentrating the Botanical Section of the Institute in the area allotted to it and for the construction of a batch of 12 clerks' quarters have been sanctioned during the year.

The following works which were under construction have been completed:—(a) A building for the Pusa High School, (b) an out-patients' block for the hospital, and (c) a general drainage scheme for the main residential area of the Estate.

Library. In addition to 381 periodicals and 1,869 books, bulletins, reports and reprints received in exchange, 262 periodicals and 228 volumes of new books, pamphlets, etc., were purchased during the year. The preparation of a supplement to the Library Catalogue, corrected up to 31st December 1926, has been put in hand.

Hospital. Medical relief was afforded to 322 in-patients and 13,056 out-patients during the calendar year 1925 as

against 354 and 14,348, respectively, in 1924. Among cases of the more important tropical diseases, 335 were of *kala-azar*, 170 of hookworm disease, 6 of cholera, 11 of plague, 7 of leprosy, 91 of dysentery, and 1,419 of malaria. Of the 2,040 operations performed, 76 were "selected" ones.

The health of the residents on the Estate continued, on the whole, satisfactory, and there were no serious outbreaks of epidemic disease throughout the year under review.

The term of Mr. D. F. Michael, I.M.D., as Medical Officer, has been extended for a further period of two years from October 1925.

VI. ACCOUNTS.

The total expenditure during the financial year ending 31st March 1926, as shown below, was Rs. 7,34,348.

	Rs.
General expenditure of the Institute including Agricultural Adviser's Office	2,85,117
Botanical Section	44,137
Chemical Section	53,137
Bacteriological Section	59,842
Mycological Section	31,527
Entomological Section	70,456
Agricultural Section	1,28,413
Sugar Bureau	34,480
Sugar Cable Service	27,239
TOTAL	7,34,348

The following are the principal items of expenditure out of the grant of Rs. 7,500 placed at the disposal of the Agricultural Adviser for expenditure in 1925-26 on special agricultural experiments :—

	Rs.
Cost of two reapers for the Karnal Farm	924
Cost of a milk sterilizing machine for the Karnal Farm	1,340
Cost of an ice-cream plant for the Bangalore Dairy	894
Charges for feeding experiments conducted by the Physiological Chemist at Karnal and Hosur	737
Charges in connection with fibre-extracting experiments	139

The receipts during the year amounted to Rs. 1,22,100 as detailed below :—

	Rs.
Fees from students	2,750
Sale of farm produce	3,748
Sale of milk, cattle, etc.	40,110
Subscriptions to the Sugar Cable Service	60,844*
Other receipts	14,648
	<hr/>
TOTAL	1,22,100
	<hr/>

* Includes balance of Rs. 23,726 carried over from previous years.

VII. CONFERENCE.

The Fourteenth Meeting of the Board of Agriculture in India was held at Pusa from 7th to 11th December, 1925, under the presidency of Dr. D. Clouston, C.I.E. The meeting was attended by 47 members and 26 visitors, the latter including the Hon'ble Khan Bahadur Sir Muhammad Habibullah Sahib Bahadur, K.C.I.E., Kt., Member-in-Charge of the Department of Education, Health and Lands, Government of India, the Hon'ble Sir Saiyad Muhammad Fakhruddin, Kt., Minister-in-Charge of the Agricultural Department, Bihar and Orissa, and Messrs. W. H. Himbury and J. M. Thomas of the British Cotton Growing Association, London. Detailed proceedings of the meeting of the Board have already been published.

REPORT OF THE IMPERIAL ECONOMIC BOTANIST.

(F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S.)

I. CHARGE.

Dr. Shaw held charge of the Section throughout the year except for three weeks from 8th May to 31st May, 1926, when he was on leave.

In recognition of his long and meritorious service in the Section, Maulvi Abdur Rahman Khan was granted the title of Khan Sahib during the year under review ; he went on leave for three months with effect from 16th April, 1926. Babu Kashi Ram officiated as First Assistant during this period and held charge of the Section during the absence of the Offg. Imperial Economic Botanist. All the staff have worked well during the year under review.

A sum of approximately Rs. 2,500 was realized from the sale of improved seed, etc., and credited to Government during the past financial year.

II. TRAINING.

Mr. Nand Lall Dutt, M.Sc., completed his course of study in October 1925, and subsequently received an appointment as Second Cane Breeding Expert at the Cane Breeding Station, Coimbatore. Thakur Ram Pratab Singh Chauhan, L.Ag., continued his course of study. Two new students, Mahbub Alam, M.Sc. (Lucknow), and Sailesh Chandra Roy, M.Sc. (Allahabad), were selected as post-graduate students and joined the course in November.

During the month of January a class of two students from the Institute of Animal Husbandry, Bangalore, attended a special course in plant-breeding. The course lasted for 12 days and proceeded on the lines laid down in the last annual report.

III. INVESTIGATIONS.

The cold weather season of 1925-26 was not generally so favourable in Bihar as the preceding season. This is to be

attributed largely to the failure of the late rains at the close of the monsoon and to the unequal distribution of rainfall during the monsoon. Crops in the Botanical Area were however satisfactory; the more important returns are shown in the following table:—

Outturn of grain in 1926.

Crop	Variety	Plot	Area in acres	Actual outturn of grain		Outturn per acre		REMARKS
				N'd.	Sr.	Md.	Sr.	
Wheat	Pusa 4 . .	Orchard 2C . .	0.71	10	22	14	34	
	" . .	Orchard 2B . .	0.71	11	34	16	28	
	" . .	Orchard 2A . .	0.71	16	11	22	37	
	" . .	N. T. G. 10 . .	1.78	30	35	17	14	
	Pusa 6 . .	Orchard 3B (part) .	0.406	7	24	18	29	
	Pusa 12 . .	N. T. G. 4 . .	0.33	6	38	21	2	
	" . .	N. T. G. 5 . .	1.00	17	17	17	17	
	" . .	Orchard 4A . .	2.03	35	30	17	24	
	" . .	Orchard 4B . .	2.00	34	25	17	12½	
	Pusa 80-5 .	Orchard 5B . .	0.60	12	12	20	20	
	Pusa 90 . .	Orchard 5A . .	0.62	11	20	18	22	
	Pusa 54 . .	Orchard 3A . .	0.077	1	17	18	20	
	Pusa 101 .	" . .	0.077	1	20	19	19	
	Pusa 106 .	" . .	0.077	1	20	19	19	
	Cawnpore 46 .	" . .	0.077	1	23	20	18	
	Lyallpur 8A .	" . .	0.077	1	14	17	21	
	Lyallpur 8B .	" . .	0.077	1	15	17	34	
Gram	Pusa 52 . .	Punjab Exptl. Area No. 27.	0.25	2	16	9	24	<div> <div>The total yield was 116 md; and 30 sr. from 7 acres.</div> </div>
		Punjab Exptl. Area No. 14.	0.25	5	27	22	28	
	Type 17 (seed of 1923).	Orchard 6B . .	0.72	15	18	21	18	Late sowing.
	Type 17 (seed of 1925).	" . .	0.72	16	6	22	17	
	Type 17 . .	Orchard 6A . .	1.57	20	11	12	36	
	" . .	S. Orchard Border .	0.60	8	13	13	35	
	" . .	S. Barah Border .	0.40	8	32	22	0	
	Type 25 . .	S. T. G. 8 . .	0.31	2	28	8	27	
	Type 9 . .	Barah 7. . .	0.49	3	25	7	16	
	Type 6 . .	Barah 6 . .	0.44	2	20	5	27	
Linseed	Type 12 . .	Barah 2 . .	1.01	10	29	10	25	
	Type 121. .	Barah 4 . .	0.75	7	9	9	25	

Outturn of grain in 1926—concl'd.

Crop	Variety	Plot	Area in acres	Actual outturn of grain		Outturn per acre		REMARKS
				Md.	Sr.	Md.	Sr.	
Oats.	Selected Pusa	Barah 1 (Part)	0.25	9	30	39	0	
	Meerut	"	0.25	8	37	35	28	
	"	"	0.05	1	32	36	0	
	"	"	0.08	2	36	36	10	
	Local	Pentagonal	1.50	34	23	23	2	Late sowing.
	"	Pentagonal E. border	0.11	4	20	40	36	
	"	Lawn plot 1	1.22	37	30	30	38	
	"	Lawn plot 2	0.37	11	0	29	29	
	"	Lawn plot 3	0.34	8	23	25	9	
	"	Musahars' plots	1.59	22	7	13	37	Inferior soil.
Arhar	"	S. T. G. 9	0.20	5	8	26	0	
	Local	Pentagonal field	2.72	27	36	10	10	
	"	Riverside E. plot	0.7	13	20	17	31	
	"	N. T. G. 8	0.34	7	19	21	39	
	"	N. T. G. 9	0.40	8	18	21	5	
Jute	Chapra	N. T. G. 3	0.3	6	27	18	22	
	Dacca 27.	Musahars' plot	0.80	6	18	8	2½	

Wheat. A relatively large part of the total area cultivated in the Section was devoted to the multiplication of the Pusa wheats, and the Imperial Agriculturist also allotted to this Section seven acres on the farm for this purpose. The following approximate quantities of the different wheats were distributed to Provincial Departments of Agriculture and to private growers :—

	Md.
Pusa 4	78
Pusa 6	8
Pusa 12	78
Pusa 52	100
Pusa 80-5	3
Pusa 90	1

Pusa 52 did well in Bihar during the past season. At the Government farm, Sepaya, a yield of 25½ maunds of grain

per acre was obtained ; on the Dalsing Sarai estate the yield was 24 maunds per acre, and on the Benipore estate the yield was 32 maunds per acre. This wheat has now been adopted for seed distribution by the Department of Agriculture, Bihar and Orissa. In the Central Provinces, Pusa 52 yielded 31 maunds per acre on a private farm, and in the United Provinces similar yields were obtained on Government farms in the Western and Northern Circles.

Pusa 80-5 gave $30\frac{1}{2}$ maunds per acre at Sepaya, $25\frac{1}{2}$ maunds at Gurdaspur and $21\frac{1}{4}$ maunds at Cawnpore. Trials with this wheat will be extended during the coming season.

Indents for Pusa wheats were received from private growers and Departments of Agriculture in foreign countries and British Dominions and Colonies. Consignments were sent to Australia, South Africa, Kenya, Ceylon, Egypt, Iraq, Algeria and Japan.

Biometrical data on the Pusa wheats were accumulated, and the first generation hybrid of the crosses between Pusa wheats and Federation was grown.

Oats and Barley. Nine types of oats have been selected and are being maintained in pure culture. Sufficient seed should be available shortly for the testing of these types on a field scale. All the types appear to be good yielders but they vary considerably in date of flowering and time of ripening ; the earlier flowering types will probably be most suited to North Bihar. An attempt was made to cross some of these types with the Scotch Potato oat. This latter is a very late flowering oat in Bihar, being nearly two months behind the other oats ; considerable difficulty was therefore experienced in making the cross. Sowing the Potato oats early in soil which was kept cool by ice enabled the seed to germinate but did not appreciably accelerate the date of flowering. A little hybrid seed was finally obtained by crossing the Potato oat with late sown oats of the Pusa types. This seed will be sown during the coming season but it does not look very promising. A mixture of the Pusa selected oats, sown on $\frac{1}{4}$ acre plot, gave a yield of 9 maunds 30 seers grain and 12 maunds 13 seers straw. A sample of oats from Meerut in a similar plot gave 8 maunds 37 seers grain and 16 maunds

29 seers straw ; pure line cultures of the Meerut oats are being isolated.

Pure line cultures of 27 types of barley were continued and will be tried on a field scale when sufficient seed has been accumulated.

Maize. A study of this crop was commenced and samples of maize were obtained from Kashmir and from the Pusa farm. In all nine different varieties of maize, each kind from a single cob, were grown. Four varieties were yellow soft, two varieties were white soft and three varieties were white-seeded dent corns. One of the Kashmir types tillered very copiously, producing numerous side shoots. It was hoped that this would prove a useful maize for fodder, but the actual weight of green plant produced was less than that from ordinary maize under similar conditions ; this type was therefore discarded as its cob did not set good seed. Four other types proved unsatisfactory and the study was therefore restricted to four races, two yellow soft and two white soft. Observations on height of plant, date of flowering, height at which cob appears, percentage of plants with two cobs, weight of cob and percentage of starch in the flour were taken, and as a result two more cultures were eliminated. The selections are now restricted to two cultures from which cobs from single plant will be used for ear to row tests in the coming season. Self-fertilization was carried out in some individuals in each culture to study the effect of inbreeding and also to obtain homozygous seed. Owing to the fact that natural cross-fertilization occurs so extensively in maize, it is of course impossible to effect much improvement in this crop by the distribution of improved seed. Any improved type which results will necessarily be restricted to Government farms and estates on which the authorities appreciate the necessity of limiting the cultivation of this crop to a single type. The present research is conducted primarily for instructional purposes, but may result in the production of an improved variety which can be used locally on the Pusa farm.

Tobacco. Work on this crop was continued on the lines laid down in the previous annual report, and the first hybrid

generation of the cross between Pusa Type 28 and the imported varieties was grown. Considerable trouble was experienced owing to a bad outbreak of "leaf curl". This condition of the plant has been described in the Kameruns where it is attributed to a curious condition of the soil which results in the surface layer becoming very dry. Owing to this dryness of the surface soil the plants are unable to obtain sufficient mineral salts, and in consequence the translocation of carbohydrates in the leaves is interfered with, leading to the proliferation of leaf tissue which is known as leaf curl. The climatic and soil conditions in Bihar, during the past year when this "disease" was severe, tend to support this view, and experiments are being devised during the coming season to test the correctness of this hypothesis.

Trials of the American tobaccos, Adcock and Burley, were carried out during the year under review, with special reference to their growing and yielding power in Bihar and to the possibility of obtaining a cured leaf which would be comparable in colour, burning and smoking qualities to that which is popularly known as Virginian. In the experiments carried out in 1924-25, Adcock and Burley tobaccos were both transplanted very early as it was anticipated that in the Bihar climate they would be slow in coming to maturity. This expectation was not realized, and it was necessary to harvest both tobaccos in January when the low temperature and high humidity were not favourable for curing. In spite of this, Burley cured to the mahogany colour which is typical of this tobacco; Adcock, however, failed to cure to the bright lemon colour which is required of this tobacco for cigarette manufacture. In the season 1925-26 transplanting was carried out much later with the object of obtaining a more favourable curing season. In both seasons the yields were satisfactory; Adcock gave on the average 1,000 lb. and Burley 1,200 lb. of dry leaf per acre. These tobaccos can therefore be grown successfully in Bihar, and the results obtained in the curing experiments described below suggest that success may be achieved in producing a bright cigarette tobacco in Bihar.

Burley tobacco ripens on the field to a lemon yellow colour and takes on a brown colour on the racks. The colour of the cured leaf varies from light to dark brown according to the climatic conditions at the time of curing, the lighter shades of brown being obtained when the air is dry. Our experience has been that Burley cannot be cured to a bright yellow colour in Bihar by air-curing. Adcock tobacco does not ripen to a yellow colour on the field, and we have not succeeded in obtaining a satisfactory colour by placing the plants directly on racks in the air. If the weather happens to be dry when the plants are placed on the racks, the leaves dry up very quickly without much change and a large proportion of green leaves results in the cured product. If the weather happens to be moist, the leaves darken to a reddish brown colour on the racks. To overcome this difficulty the following method was adopted. After harvesting as soon as the plants were sufficiently wilted to bear transshipment to the vicinity of the racks they were placed in long narrow heaps on the ground. The heaps were about 4 feet wide and 9 inches high and were covered with a thin layer of dry grass, so as to prevent rapid evaporation. After 48 hours the leaves were a uniform bright yellow colour and the plants were then transferred to the racks. If the temperature is high, about 90 Far., and the humidity is low, 30 to 70 per cent., during the first four days on the racks, then the bright yellow colour which is required in Adcock tobacco for cigarette purposes will be fixed. On the other hand, if a moist atmosphere and low temperature prevail after the plants are placed on the racks, then the leaf darkens to a reddish brown colour. Both these conditions were well demonstrated during the past season. The first lot of Adcock which was placed on the racks cured to a very unsatisfactory colour as the weather was moist, whereas when the second lot of Adcock was placed on the racks the weather conditions were much drier, the humidity during the greater part of the day ranging from 54 to 34 per cent. This tobacco cured to a satisfactory bright colour. As a result of this year's work we conclude that Adcock can be cured to a bright colour in Bihar by first wilting of the leaf in a grass heap and then placing on racks

in a dry warm atmosphere. Experience of the Bihar climate, however, shows that we can by no means rely on a prevalence of dry west winds during the curing season, and it appears that some method of controlling air temperature and humidity must be adopted if we are to be certain of the quality of our product.

With the object of testing the results which might be obtained by controlling the air temperature and humidity during curing, a small quantity of Adcock tobacco which had been wilted to a yellow colour in a grass heap, as described above, was placed on racks in a room which was heated by a closed stove. The stove was kept burning for three days during which time the temperature in the room rose from 80 to 100 Far., and the humidity fell from 75 per cent. to 36 per cent. Under these conditions the bright yellow colour was fixed in the leaf.

The smoking and burning qualities of the Adcock tobacco cured in this manner have been tested by an expert and pronounced to be very good. A more extensive trial of this method of curing will be carried out in the current year. The Second Assistant, Babu Kashi Ram, has done very good work on this subject.

Rahar (Cajanus indicus). The result of the experiment which has for its object the isolation of a type of *rahar* resistant to wilt disease will be found in a joint report with the Imperial Mycologist (page 208).

These results will be studied in relation with those obtained in the isolation of unit species in *rahar*. This work was commenced during the year under review, and some 240 different cultures are being studied and classified; the First Assistant is carrying on this branch of the work.

Fibres. The eight types of *Hibiscus cannabinus* which were isolated in 1911 were maintained in culture, and small quantities of seed of the best types were distributed. These cultures have been propagated from selfed seed for many years, and in the last few seasons it has been observed that in these progenies from selfed seed the number of sterile or incompletely fertile plants is on the increase. As a rule sterile plants grow for some time in the normal manner, but when they are about

two to three feet high the internodes become short and the leaves shorten and curl up, giving the plant a bushy virescent appearance. Such plants produce few capsules or none at all. In the past season in the progeny of four single plants of Type 1 the proportions of normal, intermediate and sterile plants were as follows :—

No. of plant	Description of seed	CLASS FREQUENCY WITH PROGENIES			
		Normal	Inter- mediate	Sterile or crowded	Total
1	Seed from plants which were bagged every season.	5	11	38	54
2	Ditto	4	13	44	61
3	Seed from plants bagged in the previous season (1924) but not bagged in 1923. The history of earlier years not known exactly.	17	7	31	55
4	Ditto	8	13	33	54

The above results indicate that continued selfed plants produce more sterile plants than those in which the possibility of cross-fertilization is not excluded. The causes of sterility are being investigated.

A new type of jute, number D. 27, obtained from the Fibre Expert, Bengal, gave a yield of 8 maunds of seed per acre ; this type appears to do well in Bihar. Further trials as laid down in the previous report are in progress.

Gram. The Pusa types of gram were maintained in culture and the following approximate quantities of the two most favourable types were distributed :—

	Md.
Type 17	23
Type 25	25

Other new types are being isolated and their classification will be published in due course.

A study of the incidence of sterility and the number of seeds per capsule in the 25 Pusa types was carried out. It

was found that the proportion of sterile capsules ranged from 3 per cent. to 27 per cent., and that generally a majority of the capsules were one-seeded. The preponderance of one-seeded capsules is most marked in the large-seeded types (1 to 5) which show about 85 per cent. one-seeded capsules, about 3 per cent. two-seeded and about 12 per cent. sterile. On account of these factors these types are not such good yielders as Types 18 and 25 in which the proportion of two-seeded capsules is higher, reaching about 28 per cent. Attempts to obtain crosses between a large-seeded and a small-seeded type met with considerable difficulties as the flower proved very delicate and susceptible both to the mutilation which is unavoidable during emasculation and to the high humidity which occurs inside the covering bags. These troubles were overcome and some hybrid seed has been obtained from crosses between Type 1 and Type 25 and from crosses between Type 2 and Type 18. In the latter cross the first hybrid generation has been grown. The F_1 plant resembled Type 18 in possessing light green leaves with a slight reddening on the margin of the leaf and on the stem. The pink flower colour of Type 18 proved dominant to the white colour of Type 2. This research is being carried on by the students. The investigation into the wilt disease of gram is being carried out by the Imperial Mycologist, this Section assisting in the supply of pure line seed.

Oil-seeds. The hybridization work on linseed outlined in the last annual report was continued and during the past season the first hybrid generation was grown. The investigation into the variation in the incidence of wilt disease (*Fusarium Linii* Bolley) on different unit species of linseed is being continued by the Imperial Mycologist, this Section assisting as in the similar investigation with gram. The following quantities of seed of the Pusa types were distributed :—

	Md.
Type 12	9
Type 15	$\frac{1}{4}$
Type 50	$\frac{1}{2}$
Type 121	9

Small quantities were also sent to the Departments of Agriculture in Iraq and Minnesota (U. S. A.).

A classification of ten new types of safflower was completed and will be published in due course. The unit species of sesamum are being isolated and 104 preliminary selections have been made.

Sugarcane. The trial of sugarcane seedlings received from the Sugarcane Breeding Station, Coimbatore, was continued. The difficulties in packing these seedlings for the long rail journey have been largely overcome by the Sugarcane Expert and a considerable proportion of each consignment reaches Pusa in good condition. At Pusa the principal difficulty in rearing these seedlings is caused by the ravages of white ants in the field. It is possible that the heavy green-manuring which has been carried out in the Botanical Area in past years has made this pest of exceptional virulence in this area. Measures were devised by the Imperial Entomologist and proved partly successful in lessening the evil. At the present moment canes from the first batch of seedlings are growing well and should yield material for analysis and subsequent selection on a basis of sugar content.

Hemp (Cannabis sativa). During the year under review an experiment was started to investigate the factors which influence the sex ratio in hemp (*Cannabis sativa*). This plant was selected as being a convenient dioecious organism in which hermaphrodite individuals are fairly common. A study of about 2,000 plants, grown at Pusa, showed that the ratio of male, female and monoecious individuals was as $1 : 3 : \frac{1}{2}$. Previous investigators have established that a change of sex in a plant of *Cannabis* could be brought about by inducing a disturbance in the physiological equilibrium of the plant, the methods generally used being the mutilation of flowers and vegetative parts and the injection of chemical substances. Some preliminary experiments on these lines were carried out in the Botanical Area, and of 56 plants mutilated or otherwise treated only four showed a regular reversal of sex. On the other hand, 322 plants out of a total population of 1932 or 16.7 per cent. showed a natural change of sex. In these

plants as soon as normal flowering had ceased a secondary crop of flowers, though fewer in number, appeared but they were all of the opposite sex. This fact tends to show that no definite conclusions could be drawn, at least this year, from the few artificial reversals obtained. Kenji Hirata reports that in the variety Karafuto about 50 per cent. of both male and female plants reversed their sexual expression through the mutilation caused by the removal of certain parts of the branches and stems at the early stage of flowering. In the variety Tochigi however the rate of sex reversal was extremely low under the same treatment. It seems quite probable, therefore, that the variety of hemp used in this experiment may be like the Tochigi variety of Hirata—one in which the rate of sex reversal in response to mutilation is very low.

Cieselsky claims that hemp pollinated with fresh pollen produces a great preponderance of staminate plants, while pollination with old pollen gives a preponderance of carpellate plants. To test the validity of this statement half a dozen plants of hemp were pollinated with fresh and another half a dozen with stale pollen (10 hours old), and the seed of these has been kept separately for trial next year.

The Third Assistant, Babu Rakhal Das Bose, has done useful work on this subject and also on the investigation on oats.

Fruit. Two varieties of loquats, Pale Yellow and Golden Yellow, were formerly grown in the Botanical Area, and both varieties bore fruit profusely. After some years all the Pale Yellow variety were cut out and only the Golden Yellow type remained in the garden. From the time of cutting out the Pale Yellow variety the Golden Yellow type failed to set fruit although it produced flowers abundantly. Experiments carried out by the First Assistant have shown that this sudden sterility in the Golden Yellow loquat is due to the fact that both types are self-sterile and that one variety will only set fruit when pollinated from the other. Some Pale Yellow loquats have now been obtained from Saharanpur and planted near the Golden Yellow plants; the Pale Yellow formed some flowers this year and as was expected the neighbouring branches of the Golden Yellow formed fruits but the branches which

were more remote did not do so. When the Pale Yellow plants have grown larger both types will probably begin to fruit in a normal manner.

Miscellaneous. The isolation of unit species of chillies was commenced and about 125 single plant cultures are being studied. A study of the unit species in peas is also in progress and a representative collection of pulses, *mung*, *urid*, *masur*, has been made from the more important districts where they are generally grown with the object of isolating unit species in these crops.

IV. PROGRAMME OF WORK FOR 1926-27.

Investigations will be continued on the lines indicated in this report on the following crops:—Wheat, oats, maize, tobacco, chillies, pulses, hemp, etc. Experiments in the curing of tobacco and on the incidence of wilt disease in *rahar* will also be carried out. The training of students will proceed as in past years.

V. PUBLICATIONS.

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|----------------|---|---|---|
| Shaw, F. J. F. | . | . | The Supply of Seed of Improved Varieties of Crops from Pusa. <i>Agri. Jour. India</i> , XXI, 1926, Part III, pp. 190-193. |
| Ditto | . | . | Summary of the Progress of Research in Agricultural Botany for the year ending 31st March, 1926, for inclusion in the Report for the Privy Council. |

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST.

(J. N. MUKERJI, B.A., B.Sc.)

I. ADMINISTRATION.

Dr. J. Sen officiated as Imperial Agricultural Chemist till 3rd November, 1925, when Dr. W. H. Harrison returned from leave. Dr. Harrison held charge of this Section till 4th May, 1926, when he took over the office of the Agricultural Adviser to the Government of India, and Mr. J. N. Mukerji assumed charge of the duties of the Imperial Agricultural Chemist.

From 4th February, 1926, the services of Dr. J. Sen, Supernumerary Agricultural Chemist, have been placed temporarily for two years under the Forest Department as Bio-Chemist in the Forest Research Institute, Dehra Dun.

Dr. A. N. Puri, who has been recently appointed as Physical Chemist, joined duty on 3rd May, 1926.

Mr. P. B. Sanyal officiated as First Assistant from 5th October to 21st November, 1925, during the absence of Mr. J. N. Mukerji on leave.

II. EDUCATION.

Mr. Sher Singh Mangat, M.Sc., selected for post-graduate training in the Section, joined his course in November 1925, and is continuing his studies here. Mr. A. T. Sen, M.Sc., the senior post-graduate student, is about to complete his two years' course by the end of August 1926.

III. METEOROLOGY AND DRAIN-GAUGES.

The usual meteorological and drain-gauge observations were maintained. The crops and drainage waters from the gauges were examined in the usual manner.

IV. GENERAL ANALYTICAL WORK AND ASSISTANCE GIVEN TO OTHER SECTIONS.

A. The following samples were analysed and reported upon :—

Soils	3
Manures	23
Feeding stuffs	12
Oil-seeds	37
Sugarcanes	8
Milk	2,623
Water	1
Oils	4
Plant	1
Miscellaneous	3
TOTAL	2,715

Three samples of soil and one of weed were analysed at the request of the Director, Institute of Plant Industry, Indore. One sample of water was received from the Patiala State and one sample of incinerator ash from the Executive Officer, Lucknow Cantonment. A sample of linseed plant was sent by the Director, Civil Veterinary Department, Bihar and Orissa, with an enquiry about the possible presence of poisonous principles which were, however, found to be absent.

B. The following assistance was rendered to other Sections :—

Agricultural Section. Nine samples of manures, one feeding stuff, and 2,623 samples of milk were examined.

Botanical Section. Eleven samples of feeding stuffs and 37 samples of oil-seeds were analysed.

Sugar Bureau. Nine samples of manures and eight samples of sugarcane were reported upon.

V. RESEARCH AND INVESTIGATIONS.

The determination of available phosphoric acid in soil. The estimation of available phosphoric acid in soil by the potassium carbonate method is being further investigated by Mr. Das. This method was already shown to be of much use in

the case of calcareous soils where Dyer's citric acid process fails. It was shown last year that the method was equally applicable to other types of soil, *e.g.*, acid soils from Assam and Burma, laterite soils from Bengal and non-calcareous soils from Madras, and the figures obtained compared well with those given by Dyer's citric acid process. During the year under review the method was further extended to several type soils obtained from different parts of India, the manurial and cropping history of which is known. The results obtained serve to differentiate between manured and un-manured plots and compare favourably with those given by Dyer's citric acid method. A few typical examples are set forth below.

Description of plots	AVAILABLE PHOSPHORIC ACID	
	Citric acid method	Potassium carbonate method

I. Laterite soils.

North Hazi, Blocks A & D, Dacca—

Green manure	0.0018	0.0072
Green manure+Lime	nil	0.0054
" " +Cowdung	0.0021	0.0096
" " +Cowdung+Lime	0.0007	0.0075

Basu's Experimental Plots, Dacca—

No manure	nil	0.0074
Bonemeal	0.0020	0.0081
" +Lime	0.0015	0.0063

II. Acid soils.

Block E, Jorhat Farm, Assam—

Phosphated	0.0043	0.0093
Non-phosphated	0.0034	0.0083

Karimganj Farm, Assam—

Control	0.0006	0.0062
Bonemeal	0.0021	0.0074

Description of plots	AVAILABLE PHOSPHORIC ACID	
	Citric acid method	Potassium carbonate method

*II. Acid soils—concl'd.*Cinchona Camp, *via* Mergui, S. Burma—

Bad soil from ridge	0-0015	0-0046
Good soil from slope	0-0090	0-0079

III. Non-calcareous soils.

Nandyal Agricultural Station, Madras—

No manure	0-0034	0-0005
Cattle manure	0-0300	0-0014
No manure	0-0065	0-0004
Cattle manure	0-0111	0-0010

Koilpatti Agricultural Station, Madras—

No manure	0-0074	0-0001
Superphosphate	0-0096	0-0010
Superphosphate and Cyanamide	0-0097	0-0010

Government Farm, Etawah, United Provinces—

No manure	0-0518	0-0083
Farmyard manure	0-0233	0-0044

Chandkhuri Experimental Farm, C. P.—

Cotton area, fertile	0-0015	0-0059
[Cotton area, less fertile	0-0015	0-0060

Indore soil, Central India—

Light cotton soil, un-manured	0-0018	0-0001
„ „ „, fertile	0-0070	0-0028
Deep cotton soil, un-manured	0-0015	0-0009
„ „ „, manured	0-0085	0-0026

Lyalpur Agricultural Station, Punjab—

Control	0-0831	0-0033
Bonemeal	0-0911	[0-0038

Description of plots	AVAILABLE PHOSPHORIC ACID	
	Citric acid method	Potassium carbonate method

III. *Non-calcareous soils*—concl'd.

Gurdaspur Agricultural Station, Punjab—		
Control	0-0113	0-0041
Superphosphate	0-0175	0-0062
Complete manure	0-0210	0-0066

Utilization of Indian deposits of apatite. The results of the investigation reported last year on the utilization of apatite were written up and formed the subject matter of a paper on "The Electrolytic Production of Dicalcic Phosphate from Apatite in India" which was read by Mr. Das in the thirteenth session of the Indian Science Congress held at Bombay in January 1926.

Windrowing of sugarcane. In connection with the investigation on the deterioration of windrowed canes, it was observed that "moisture induces germination in windrowed sugarcane and brings about its abrupt deterioration", and so the deterioration of windrowed canes is to be taken rather as an indication of the setting in of the process of germination. To study this further, a set of germination tests was carried out last year with fresh canes, canes windrowed in shade for 28 days and canes subjected to preliminary soaking in water. The results obtained were promising in as much as a large majority of the buds of the windrowed canes were living and 66 per cent. of them germinated in 42 days, thus demonstrating that the vital processes in these canes continue for a considerable length of time. It was further observed that sets of both fresh and windrowed canes germinated more quickly when there was a preliminary soaking in water; in case of fresh canes soaked in water, 85 per cent. of the buds germinated in 22 days against 26·5 per cent. in case of unsoaked ones. In 42 days

91.5 per cent. of the former germinated against 73 per cent. of the latter. Similar results were obtained with windrowed canes too, where 41.3 per cent. of the buds of the soaked sets germinated in 22 days against 5.2 per cent. of the unsoaked sets, and 80 per cent. of the former germinated in 42 days against 66 per cent. of the latter.

The following table gives the analysis of the fresh and windrowed canes used as seeds in the germination test, and also of the canes obtained from them at the harvest.

Date of analysis	Description	Weight of cane in kilos	Brix	In juice		
				% Sucrose	% Glucose	Purity
20-2-25	Fresh canes before planting.		18.33	16.58	0.58	90.86
30-1-26	Crop from fresh cane sets	191.56	19.14	17.45	0.29	91.19
2-2-26	Crop from fresh canes soaked in water for 24 hrs	232.82	19.24	17.11	0.42	88.91
20-2-25	Windrowed canes before planting.		19.14	17.62	0.41	91.00
1-2-26	Crop from windrowed cane sets.	165.27	19.00	16.82	0.44	88.51
2-2-26	Crop from windrowed canes soaked in water for 24 hrs.	164.72	19.34	17.64	0.44	91.20

The above results show that canes produced from seeds of windrowed canes are as good as fresh canes or those produced from seeds of fresh canes, and thus demonstrate that windrowed canes can be utilized for seed purposes. The yield in case of fresh canes subjected to a preliminary soaking in water for 24 hours was 21.3 per cent. more than those from unsoaked ones. Soaking in water has thus the effect of bringing in a quicker germination and probably an increased yield.

Sugar-beet. It has already been shown that sugar-beet can be successfully grown under irrigation in loamy and sandy loam soils of Bihar, and that the crop can be retained in the ground for a period of about two months and a half (from the end of February to the middle of May) following the cane season. The results obtained with sugar-beet formed the subject matter of a paper on "Sugar-beet and its possibilities in Bihar" which was read by Mr. Sanyal in the thirteenth session of the Indian

Science Congress, held at Bombay in January 1926, and was also published as an original article in the "Agricultural Journal of India."

During the last winter, the experiment with sugar-beet was directed towards finding out if the roots can be successfully grown without irrigation in sandy and sandy loam soils of Bihar; the experiment proved a failure, more specially as the latter part of the monsoon was not a favourable one and there was not sufficient moisture in the soil during the time of sowing for a successful germination of seeds.

Preparation of gur by improved method. The problem of producing a *gur* superior in quality to the local production was investigated by Mr. Sanyal. In the manufacture of *gur*, lime and soda are the two substances commonly employed for the clarification of the sugarcane juice. In Bihar very seldom lime or soda is added; the juice is simply boiled down in a very shallow open pan (7 ft. diameter and $2\frac{1}{2}$ inches deep) and impurities formed as scum on the surface of the boiling juice are removed by means of ladle. Simple boiling of the juice and removing the scum make the syrup considerably clear, but when the acid juice is boiled for a long time at a high temperature it causes inversion of sucrose and consequent production of a larger amount of glucose. The presence of too much glucose retards the crystallization of sucrose and renders the *gur* very hygroscopic, and it is on this account that *gur* locally prepared absorbs moisture and deliquesces during the monsoon. Soda improves the colour but the soap that is formed remains in the mass. Lime checks inversion and efficiently clarifies the juice on boiling, but the excess of lime if allowed to remain probably forms calcium glucosate at the later stages of boiling and turns the product dark after a time. The excess of lime is removed in factories by carbonatation which is not possible to be adopted in a cottage industry. To obtain a hard light-coloured *gur* which will not absorb moisture and will not turn black in time, the following procedure is adopted:—Lime is added to the cold juice to a point showing slight alkalinity, and the juice then raised to boiling point when a small quantity of phosphoric acid barely sufficient to

precipitate the excess lime is added. When this is carefully done, a granular precipitate is formed which rapidly settles, carrying down all suspended impurities, and leaves a clear supernatant juice which can be immediately boiled down to *gur*. A very shallow pan, such as is used in the manufacture of local *gur*, should be employed; this would enable the evaporation of the juice to be performed rapidly. The temperature on no account should be allowed to exceed 115°C ., otherwise some caramel is formed resulting in the production of a darker coloured *gur* possessing a peculiar flavour with a slightly bitter taste. Five cakes of *gur*, each weighing about 14 seers, were prepared from Co.213 by adopting the above procedure. The *gur* produced was hard, light-coloured and fairly crystalline. It contained 80 to 83 per cent. sucrose, 2 to 4.5 per cent. glucose, and 1.5 to 2.3 per cent. ash, against 73.8 per cent. sucrose, 8.1 per cent. glucose and 2.5 per cent. ash contained in the *gur* prepared from the same variety of cane (Co. 213) by a local manufacturer, whose product was dark-coloured and much inferior to this. It was also observed that even using all precautions, the *gur* produced from the local Hemja variety was inferior to that from the Coimbatore cane. The possibility of producing a good quality *gur* from Bihar cane is now under investigation.

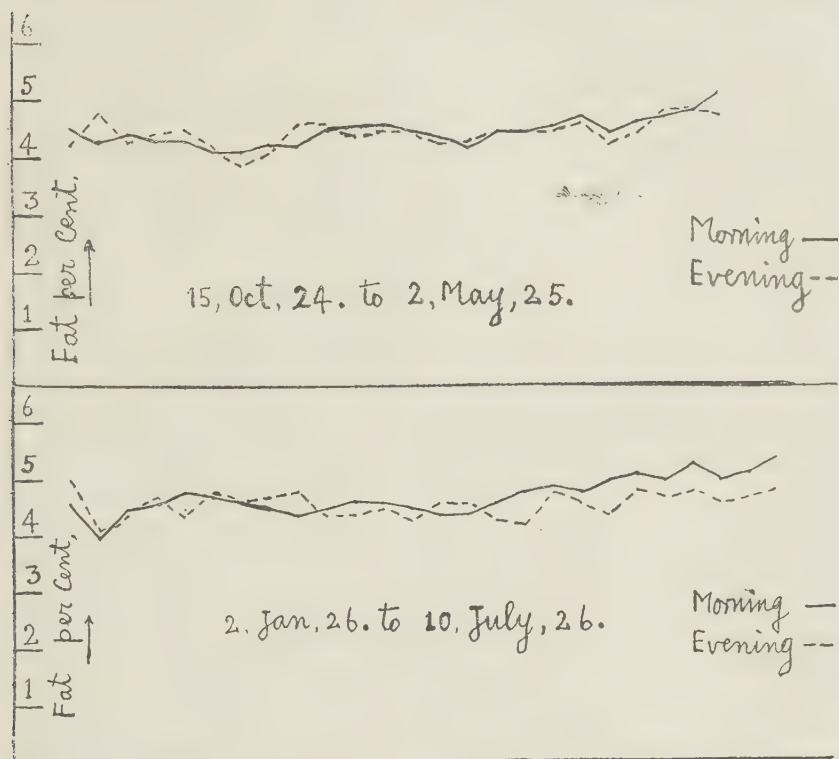
Effect of chalk on a non-calcareous soil. With a view to study the effect of chalk on a non-calcareous soil, some experiments on Kalianpur soil, which is almost devoid of lime, were carried out in this laboratory. The results obtained may be summarized as follows:—(1) The addition of chalk to a non-calcareous soil increases the crop yield as shown by pot-culture experiments. (2) The increased yield is attributed, among other factors, to the supply of calcium to the soil naturally deficient in that constituent, to the change of soil reaction in that its hydrogen ion concentration rises from the initial value of 6.3 to 7.0 or more, and also to the improved texture of the soil by its mechanical opening. The last was shown to be the case when part of the chalk added to the soil in pot-cultures was replaced by an inert substance like sand, and the yield of crops increased thereby. (3) That the mechanical opening of the soil takes

place on the addition of chalk has been shown by (i) the decreased water-holding capacity of the soil on the addition of chalk alone or of sand with a fixed amount of chalk, and (ii) the increased rate of percolation. (4) A non-calcareous soil may be considerably improved in fertility by adding about 5 per cent. of chalk to satisfy its lime hunger along with a further quantity of either chalk or sand to improve its physical condition, provided the excess is not too large. The results obtained formed the subject of a paper on "Effect of chalk on a non-calcareous soil" which was read by Mr. Das in the thirteenth session of the Indian Science Congress held at Bombay in January 1926.

Absorption of moisture by soil. Dr. Sen continued his investigation on the relation of the clay content of soils to their moisture absorption. The study of this subject has shown that absorption of water by soil when exposed to a moist atmosphere is influenced mainly by their content of clay and also that the presence of other soil colloids has a modifying influence. The influence of temperature on the amount of absorption has also been investigated. The relation is, however, subject to a deviation due to the difference in temperature of observation, and in the character of the individual soils. The results of this investigation have been submitted for publication as a Memoir of the Department of Agriculture in India. The work is of interest in that it may indicate a possible means of differentiating between various soil types.

Variations in the fat content of milk of selected cows. Samples of milk of ten cows—four of the Montgomery breed and six from the cross-bred (Ayrshire×Montgomery) herd—were examined twice daily for their fat content. In some of the cases complete figures for the whole of the lactation period are not available, but the data obtained generally show a gradual rise in the fat content with the progress of the lactation period, thus confirming previous years' results. The variation in the fat content of the milk of the Montgomery cows under observation was between 2.0 and 9.0 per cent., while in the case of the cross-bred cows, it was between 2.1 and 7.0 per cent. The examination of the milk of a cross-bred cow (Laura) during her

two consecutive lactation periods, has shown a remarkable similarity in fat content and its variation. A chart showing the weekly average fat percentage of morning and evening



Ayshire-Montgomery cross-bred cow Laura.

samples of milk of the above cow during her two consecutive lactation periods is attached to this report to illustrate the last point referred to above.

Adulteration of butter fat or ghee with foreign animal fat and its detection. The detection of foreign fats in adulterated butter fat or *ghee* is one of the most difficult problems of food analysis. This is especially so when the adulterant is an animal fat. None of the rapid tests are reliable, and an investigation has therefore been undertaken to work out a successful method for its detection. Recently we came across a sample of butter which contained 5 per cent. more fat than a sample of genuine butter prepared at Pusa and also one procured from a recognized firm did. Such tests as specific gravity,

refractive index, iodine value, Reichert Meissl value and saponification value showed no abnormality in the sample, though it was soapy to touch, greasy in taste and contained a fat difficultly soluble in ether and practically insoluble in strong alcohol. Crook's test with 2.5 c.c. of carbolic acid mixture (10 c.c. carbolic acid and 1 c.c. water) added to one gramme of the melted fat produced two distinct layers, indicating the presence of foreign animal fat in the sample. The sample was found to contain 8.45 per cent. stearic acid by Hehner and Mitchell's test, whereas the pure buffalo butter contained only 0.33 per cent.

The estimation of stearic acid in butter fat by Hehner and Mitchell's method is a laborious one, and the conditions under which the estimation is to be conducted are attained with great difficulty. Crook's method was tested and found to detect adulteration only when the sample under examination contained 50 per cent. or more of animal fat. The substitution of glycerol in place of water in the carbolic acid mixture used in Crook's test was found more satisfactory, but as carbolic acid is very hygroscopic, it becomes difficult to maintain a standard condition. Attention was therefore directed towards finding out a suitable rapid test, based on the fractional precipitation of higher glycerides (of which the animal fat mostly consists of) out of a solution of the fat in some solvent, on the addition of strong alcohol. Such solvents as acetone, carbon tetrachloride and ethyl acetate (acetic ether) were tried; the former two were found quite unsuitable and unsatisfactory, but the latter seems to satisfy the object.

By using acetic ether, a permanent precipitate was obtained with samples containing as low as 6 per cent. foreign animal fat, and there was an increasing proportion of the precipitate as the proportion of foreign animal fat was increased. The possibility of estimating foreign animal fat quantitatively by this method is now under investigation.

The movements of nitrates in the soil and subsoil. As in previous years, the main energies of the Section were directed towards this investigation; 954 samples of soil and subsoil were collected in this connection during the year and examined

for their moisture and nitrate contents. In addition, electro-metric conductivity measurements of the extract of these soils were taken and very characteristic curves were obtained which possibly may help to elucidate the movements of soil nitrate and water. The study of this subject, as in last year, was carried out in four areas under different cultural conditions, *viz.*, pasture, fallow, unirrigated cropped land and cultivated plot receiving irrigation. The observations are still being continued in the first three; mention may, however, be made of some of the broad features observed.

The report submitted last year carried the observation to the end of June 1925, when in the pasture area there was observed a uniform distribution of nitrate in the soil layers, 0.6 to 1.0 lb. nitrogen per acre half foot being present. With the advent of monsoon and a fall of about 5 inches of rain between 17th June and 8th July, no nitrification was observed in any of the soil layers, not even on the surface. As the monsoon proceeded, water in the soil moved downwards, but no increasing amounts of nitrate were noticed either on the surface or at the lower depths until the first week of October, when there was a slight increase in the nitrate content at the surface from 0.8 to 1.7 lb. nitrogen per acre half foot.

In 1924, in the pasture area an occurrence of nitrification was noted in the surface layer (second six inches) with the advent of the rains, and as the monsoon proceeded, the drainage became heavier and increasing amounts of nitrate were washed down into the lower depths. This wide divergence between the results of two years' experiment in the pasture area may be due to a difference in the character of the two monsoons; the one of 1924 being heavier in the earlier part with little or no breaks, whereas that of 1925 was lighter with frequent breaks. Whatever nitrates in the surface were formed after each fall, were more or less consumed by the growing herbage, with the result that no increase in the nitrate content could be noticed in the pasture area during the last monsoon.

When the first samples of the second series in the fallow plot were collected on 19th June, the distribution of nitrate,

except that in the upper layer of soil, was found to be varying between 1.8 and 1.0 lb. nitrogen per acre half foot. As in the previous year and unlike the pasture, the fallow plot was very rich in nitrate in the topmost layer. This is due to the fact that the surface soil here had all along been kept disturbed. With the advent of the rains, there was a quick response of the nitrification processes, and as the monsoon proceeded, nitrate was gradually washed down to the deeper subsoil. The amount of nitrate in the fallow plot all along remained much higher than in the pasture, and in contradistinction to this latter plot, the fallow area, from the surface down to sixth foot, continued to be very rich in nitrates upto the end of March, after which the distribution tended to be of the same type as that noticed the previous summer. It thus confirms the last year's results. The results obtained with the cropped plot were similar to those arrived at in previous years.

The investigation, on the whole, shows and confirms the previous years' results that the distribution of nitrates in soil, besides being regulated by rainfall and the physical character of the subsoil layers, is profoundly modified by the cropping and the cultural operations which the field receives. The main features brought out is that very considerable quantities of nitrate are washed into the subsoil and ultimately lost, and that there is no appreciable upward movement of these subsoil nitrates.

VI. PROGRAMME OF WORK FOR 1926-27.

A. Imperial Agricultural Chemist.

Major subjects.

1. Continuation of the investigation into the amount and nature of drainage water from cropped and fallow land.
2. The influence of manuring on the composition of crop.
3. The estimation of the available P_2O_5 by means of alkaline carbonate solution in calcareous soil and other types of soils and its relation with cropping value and manurial reaction.
4. The movement of nitrates and water in Pusa soils.

5. Further investigations into the possibility of sugar-beet cultivation in Bihar.

6. Variations in quality of milk from selected cows.

7. A study of the course of changes occurring in the tobacco leaf under various methods of curing.

8. The detection and quantitative estimation of foreign fat in adulterated butter fat or *ghee*.

9. A study of the chemical and physical factors involved in combined applications of green manures and superphosphates.

10. The preparation of *gur* by improved method.

Minor subjects.

1. A comparison of the accuracy of various analytical methods.

2. Analytical work for other Sections.

B. Physical Chemist.

1. A critical study of the methods of mechanical analysis of soils.

2. Measurement of vapour pressure of glycerine-water mixtures of various concentrations for studying soil moisture relationship.

3. Investigation to determine the nature of the alleged "unfree" water in soils.

4. Studies in the absorption of water vapours from unsaturated atmosphere and its relation to the nature of replaceable bases and certain other physico-chemical properties of the soil.

5. The role of electronegative ions in the soil with particular reference to the absorption of acid radicals, and its use for the measurement of specific surface in soil.

6. Investigations on the mechanism of water absorption in soils.

7. Studies in soil reaction :—(a) Comparison of the "quinhydrone" and "hydrogen electrode" for the study of reactions in Indian soils. (b) Buffer action of Indian soils.

VII. PUBLICATIONS.

- Das, S. L. The Determination of Available Phosphoric Acid of Calcareous Soils. *Mem. Dept. Agri. India, Chem. Series*, Vol. VIII, No. 6.
- Harrison, W. H. Report of the Progress of Agricultural Chemistry in India for the year 1925-26 for the Committee of the Privy Council for Scientific and Industrial Research, London.
- Sanyal, P. B. Deterioration of Sugarcane during its Storage by Windrowing. *Mem. Dept. Agri. India, Chem. Series*, Vol. VIII, No. 7.
- Sen, J. Standard Methods of Analysis of Fertilizers. *Pusa Agri. Res. Inst. Bulletin* 164.
- Sen, J., and Amin, Bhailal A Study of Absorption of Moisture by Soils. *Mem. Dept. Agri. India, Chem. Series*, Vol. VIII, No. 12. (*In the press.*)

REPORT OF THE IMPERIAL AGRICULTURAL BACTERIOLOGIST.

(J. H. WALTON, M.A., M.Sc.)

I. ADMINISTRATION.

Mr. C. M. Hutchinson held charge of the Section till 19th April, 1926, when he went on leave for 9 days, at the end of which he retired from service on 29th April, 1926, on superannuation pension. Mr. Hutchinson had held the post of Imperial Agricultural Bacteriologist from 24th December, 1909.

I took charge of the Section from 20th April, 1926. I was on leave from July to November 1925.

Mr. N. V. Joshi, First Assistant, was on leave for 3 months and 22 days from 16th January, 1926. Mr. C. S. Ram Ayyar, First Assistant, Industrial Branch, acted in place of Mr. Joshi.

II. TRAINING.

Mr. M. R. Madhoke, B.Sc., was selected for post-graduate training in agricultural bacteriology, and joined on 4th January, 1926.

III. SOIL BIOLOGY.

Nitrogen fixation. At the end of 1922 a line of four small plots, each ten feet square, was laid down; plots 1 and 3 were unmanured and plots 2 and 4 received farmyard manure. No crop was grown on the plots, which were kept fallow and free from weeds. The total nitrogen was estimated to a depth of one foot, and nitrates to a depth of three feet, at intervals of three months or so.

The nitrate in the second and third foot was never much—1.75 mg. per 100 gm. soil was the maximum amount obtained,

and this was when the nitrate content in the first foot was high, so these amounts are not included in the table of results.

Date	Depth inches	NITROGEN CONTENT IN MG. PER 100 GRM. SOIL							
		Plot 1		Plot 2		Plot 3		Plot 4	
		Nitrate	Total	Nitrate	Total	Nitrate	Total	Nitrate	Total
22nd Decem- ber, 1922.	0-6	1.8	34.5	1.2	59.0	1.5	36.5	2.0	67.0
	6-12	0.9	31.0	1.2	54.0	0.9	31.0	0.9	52.0
23rd March, 1923.	0-6	2.1	75.0	0.6	56.0	1.8	67.0	1.8	63.0
	6-12	0.0	56.0	0.0	44.0	0.0	47.5	0.0	45.5
23rd July, 1923	0-6	2.1	77.0	1.2	63.0	2.4	70.0	1.6	71.5
	6-12	1.2	55.0	0.9	49.5	1.6	50.0	0.9	53.0
19th Decem- ber, 1923.	0-6	2.4	77.0	3.3	67.0	2.4	72.0	3.6	72.0
	6-12	1.2	56.0	1.8	48.0	1.2	48.0	2.4	52.0
25th March, 1924.	0-6	1.25	68.0	1.25	65.5	3.75	65.0	2.75	51.0
	6-12	4.0	34.45	0.75	57.5	0.75	45.0	0.75	52.0
17th June, 1924	0-6	5.0	85.0	7.0	75.0	4.0	76.0	3.0	66.0
	6-12	1.25	55.0	1.5	63.0	1.5	52.0	1.0	62.5
16th October, 1924.	0-6	10.0	52.5	12.0	55.0	6.0	55.5	9.0	64.0
	6-12	4.0	49.0	6.0	52.0	4.0	46.0	4.0	54.5
19th January, 1925.	0-6	1.0	52.5	0.75	62.0	0.75	52.0	1.0	59.0
	6-12	0.75	62.0	0.0	55.0	0.0	48.0	0.0	48.0
29th April, 1925.	0-6	1.6	60.0	1.6	55.0	1.25	54.0	1.88	54.0
	6-12	1.0	52.0	1.0	52.0	0.88	47.0	0.75	48.0
20th Novem- ber, 1925.	0-6	12.0	56.0	16.0	53.0	8.0	58.5	14.0	62.0
	6-12	4.0	54.5	8.0	47.5	4.0	46.0	8.0	45.0

The figures are of considerable interest. In the first three months the nitrogen content of the top six inches of unmanured soil had doubled, while that of the manured soil had fallen slightly, and was less than that of the unmanured plots. The nitrogen content of the manured plots thereafter never differed much from that of the unmanured plots.

The nitrate content of the plots fluctuated within wide limits, and went up to a very high figure in June 1924 and November 1925. When we bear in mind that 1 mg. of nitrate nitrogen per 100 grm. soil is the equivalent of 20 lb. of nitrate nitrogen per six inch acre, and that 1 cwt. nitrate of soda contains about 17 lb. nitrogen; further, that the increases in nitrate nitrogen in these plots from March to June and June to October 1924, the disappearance of the nitrate by January 1925, and its further formation by November 1925, all involve

several milligrams nitrate per 100 gm. soil, the economic importance of these fluctuations will be appreciated.

The fluctuations in total nitrogen point to the conclusion that while under certain conditions nitrogen-fixing bacteria become very active, adding to the soil large quantities of nitrogen, this nitrogen is in such form as to be easily lost, unless conditions are such that it is nitrified and taken up by a growing crop.

To obtain some light on the problem an intensive investigation of the soil nitrogen has been started, in which soil from the laboratory experimental area, five of the permanent experimental plots of the Punjab field, and irrigated land in the Simri *dhab* is being studied in its field condition and in the laboratory.

In the first three months it appeared that the total nitrogen content of the soil varied in the same way in the field as when the soil was kept in the laboratory, but it is unlikely that, with the alteration in the seasons, it will continue to do so.

Nitrification. It had been found that when the amount of nitrogen, either as cake or sulphate of ammonia, added to field soil exceeded 90 mg. per 100 gm. soil, no accumulation of nitrate took place, and the large quantities of ammonia added as sulphate or produced by ammonification of the nitrogen of the cake, tended to disappear. Later, it was found that rich garden soil and soil near manure pits could nitrify 90 mg. of nitrogen per 100 gm. soil, and accumulation of ammoniacal nitrogen did not take place.

Further experiments then showed that if to the field soil be first added 30 mg. of nitrogen per 100 gm. soil, and this nitrogen be allowed to nitrify during an incubation period of six weeks, then on washing out the nitrate formed in that period, the soil was able to nitrify 120 mg. of added nitrogen per 100 gm. soil.

Nitrifying organisms isolated during the study of intensive nitrification of urine were found to differ somewhat from the nitrifying organisms described by previous workers, in being able to tolerate larger quantities of ammoniacal and nitrite nitrogen, and also in being able to grow for a short time on

ordinary agar. The influence of these organisms, nitrite formers and nitrate formers, on nitrification in field soil to which large quantities of nitrogen (90 mg. nitrogen in cake) had been added, was investigated.

At the end of four weeks, the amounts of nitrite and nitrate nitrogen per 100 grm. soil, and the treatment of the soil are shown in the following table. In all cases, the moisture was made up to 16 per cent., and the temperature of incubation was 30°C.

	MG. NITROGEN PER 100 GRM. SOIL AS	
	Nitrite	Nitrate
1. Soil only . . . . .	...	5.4
2. Soil + Cake to give 90 mg. N	11.66	7.2
3. Soil + Cake as in 2 + 10 c.c. of culture of nitrate former.	0.19	52.8
4. Soil + Cake as in 2 + 10 c.c. culture of nitrite former .	3.11	5.4
5. As 3, but culture sterilized	4.67	5.4

The results show that vigorous nitrification occurs only when the nitrifying organism is added.

Fermentation of organic manures and their nitrification in soils. Composts of mustard cake alone and with soil and charcoal were fermented for fifteen weeks. The total and ammoniacal nitrogen were estimated, and the composts were mixed with Pusa soil and allowed to nitrify for eight weeks. The analyses of the composts showed that the inclusion of an amount of charcoal equal to five per cent. of the weight of cake hastened the decomposition of proteins. The greatest decomposition was in a compost of cake, soil and charcoal, where 40 per cent. of the nitrogen was ammonified. Unfortunately from this compost and from the compost of cake, soil, charcoal and sulphur, about 10 per cent. of the nitrogen was lost. Nineteen per cent. of the nitrogen was ammonified in the cake-charcoal compost; in other composts the ammonification was less than seven per cent. of the total nitrogen.

The following table shows the percentages of the original nitrogen found as nitrate in Pusa soil after eight weeks, for the several composts.

Compost	Nitrate per cent.
Cake, fresh	40.3
Cake, fermented	40.3
Cake and soil	50.3
Cake, soil and sulphur	52.0
Cake and sulphur	48.0
Cake and charcoal	58.0
Cake, soil and charcoal	48.0
Cake, sulphur and charcoal	53.0
Cake, soil, sulphur and charcoal	48.0

The cake and charcoal compost appears to be the most valuable source of available nitrogen. The addition of charcoal has the further beneficial effect of considerably modifying the odour of the fermented cake, making it both less strong and of a less offensive nature.

Biological activity in soils at low temperatures. Measurements of the biological activity in Pusa soil at temperatures below the standard temperature of 30°C., by determination of carbon dioxide production, were carried out. The amounts of carbon dioxide in milligrams, evolved in 20 days, are given. In all cases the moisture content of the soil was 16 per cent., the optimum for biological activity.

	TEMPERATURE		
	25°C.	20°C.	15°C.
Soil alone	42	..	26
Soil + Cake (to add 30 mg. nitrogen)	328	270	202
Soil + 0.5 per cent. Glucose	349	..	127
Soil + 0.5 per cent. Mannite.	295	..	208

As much carbon dioxide was given off in the first four days in the case of soil with cake or glucose, and six days in the case of soil with mannite at 25°C. as in the whole period of 20 days at 15°C. A fall of temperature from 25°C. to 15°C. thus causes biological action to be slowed down rapidly, but this action still continues with some vigour.

Investigations on bacterial activities in the Punjab field. For some years it has been noticed that certain plots in the Punjab field give a very uneven stand of crop. Patches and belts of poor stunted growth are found, and these areas in some cases amount to half of the plot. Samples of soil from good and bad patches were taken to a depth of six inches and their carbon dioxide producing, nitrification, and nitrogen fixing powers tested and compared. Small differences in their powers of nitrogen fixing and nitrification were found, and these were in favour of the bad patches. In carbon dioxide production, both when the soils alone were used and when cake was added, the good and bad patches were equal. It appears, therefore, that the irregularities in cropping power were not due to fundamental variation in the bacterial flora of the plots, but must be attributed to some other cause, such as irregularity in the distribution of subsoil moisture.

Of the permanent manurial plots in the Punjab field, it is seen every year that plot 16 A, receiving green manure and superphosphate, is far more productive than the no manure plot 11 A.

The methods of biological analysis were then applied to samples of soil from these two plots to see if the difference in the manurial treatment of the soils would have any influence on the results.

In the experiments on carbon dioxide production, without the addition of cake, the manured soil gave 40 per cent. more carbon dioxide in four days, than the unmanured, but when one per cent. cake was added to each, the amounts of carbon dioxide produced each day for 15 days and their totals were about equal—the difference between the totals was less than three per cent. Nitrification proceeded rather more rapidly in manured soil than in unmanured; the amounts of nitrate

produced after two, four, six and eight weeks were for the manured soil 7.2, 15.0, 16.8 and 20.4 mg., and for the unmanured soil 5.0, 12.0, 15.6 and 17.4 mg., respectively. In nitrogen fixing power the difference was striking. In 100 grm. manured soil after one month there was a gain of 11.5 mg. nitrogen, against a gain of only 0.5 mg. in unmanured soil. After a second month's incubation, the nitrogen content of the manured soil remained unaltered, while that of the unmanured rose by 3.0 mg. The amounts of nitrogen fixed by each soil in liquid culture media supplying complete nutrients, were equal. Further study of nitrogen fixation in these two plots is necessary before any definite conclusions can be drawn, and this will be carried on through the current year.

Green-manuring. Repetition of small plot experiments on green-manuring with cowpea, *dhaincha* (*Sesbania aculeata*), guar (*Cyamopsis psoraloides*) and sann-hemp again confirmed the previous results, that, except in the case of cowpea, in which the difference is negligible, higher yields are obtained by green-manuring with only the leafy portions of these plants than with the whole plant.

In connection with the investigations on the economic possibilities in growing sann-hemp and, while using the tops of the plant for green-manuring, obtaining fibre from the stalks, comparative tests between early and late cutting and burying the tops were carried out, to see if by later cutting, a higher yield of fibre might be obtained without detriment to the succeeding crop. It was found that the yield of oats was actually higher on those plots in which the sann-hemp tops had been buried late.

Comparison of the crops of oats from plots green-manured with sann-hemp tops and with the whole plant showed that burying of tops gave better produce than burying of whole plant. With wheat, from the total yields the advantage appeared to be the reverse of that found with oats, but the wheat had suffered so much from attacks of white ants, rust and aphids that yields were far below normal except on two plots, one in each series, where the advantage lay with the plot manured with tops only.

The yield of fibre obtained from the stalks remaining after cutting the tops of the sann-hemp amounted to four maunds per acre. In areas subject to attacks of white ants, the burying of tops alone has the further advantage that this pest does not receive the encouragement derived from the addition to the soil of the woody stems of the sann-hemp.

Decomposition of cellulose. A bacillus has been discovered, which when grown with any one of certain other organisms decomposes cellulose. It has been found that cellulose decomposition takes place not only when any one of these other organisms is grown with the bacillus in question, but also when their filtered enzymes are substituted for the organisms. No decomposition of cellulose is found if the enzyme of the bacillus be substituted for the bacillus. Why the symbiosis should be necessary has not yet been discovered, but is being investigated.

Impermeability in soils. In the course of experiments on soil toxins, it was found that colloidal substances arising during the decomposition of organic matter in soil, made the soil impervious to water. The nature of the substances and the bacteria from the action of which they arose, was investigated. From the soil of a maize culture pot which developed deficient drainage, bacteria were isolated, which, when grown in sand beds, caused these sand beds to become impervious to the passage of water. Imperviousness also developed in sand beds treated with water in which sann-hemp had been submerged for 24 hours.

The imperviousness was associated with the production of slime in the sand beds. Permeability was not restored, nor was the slime extracted, by a number of solvents such as alcohol, benzene, acetone, decinormal caustic soda. However, protracted extraction with hot water removed the slime and restored permeability.

From the hot water extract, a grey flocculent precipitate settled out at 60°—70° C. on the addition of 25 per cent. of ammonium sulphate. The precipitate gave the reactions for pectins. Several strains of rods and cocci that can cause impermeability and production of slime have been isolated.

They are facultative anaerobes thriving best in media containing carbohydrates with other organic substances.

Phosphate solubilization. The work on solubilization of phosphate in bonemeal was carried on throughout the year. The stimulating effect of the addition of 6 per cent. charcoal to the compost is shown by the analyses of two composts, one with, and one without charcoal.

	PERCENTAGE PHOSPHORIC ACID AVAILABLE	
	After 29 weeks fermentation	After 50 weeks fermentation
Bonemeal, sulphur, sand compost	39.1	36.5
Ditto ditto and charcoal .	64.0	72.6

When charcoal is added, solubilization is both more efficient and proceeds for a longer time.

The results of a small scale experiment on potato growing showed the superiority of composts of bonemeal, sulphur, sand and cake to superphosphate and cake, also that composts 27 weeks old were better than those only 13 weeks old.

Further quantities of compost are being prepared for larger scale experiments in the next season.

Laboratory experiments to ascertain the best proportions of the ingredients of the composts have been started, and these at present indicate that the most suitable amount of sulphur to be taken is one-fourth of the weight of the bonemeal in the compost.

Only a small proportion—13.6 per cent.—of the total phosphoric acid of Trichinopoly rock phosphate was found available after 47 weeks' fermentation in composts of phosphate, sand, sulphur and charcoal. When charcoal was omitted, only 8.8 per cent. of the phosphate was solubilized. No solubilization occurred either in nutrient media or composts where Singhbhum phosphate was the source of phosphoric acid.

IV. SILAGE.

A beginning was made in the study of the bacterial flora of silage. The material, chopped maize, of the age at which it is made into silage in farm practice, was filled into large glass jars and glazed earthen pots and packed tightly. At first, some of the vessels were kept uncovered, others were covered with a layer of rammed earth. It was found that a vigorous growth of mould, to a depth of about eight inches, occurred in both open vessels and in those covered with earth. Below this depth, changes took place in the maize which at the end of 12-14 days resulted in what appeared to be normal maize silage.

In the glass vessels, the changes in colour of the maize could be traced from day to day. The upper layer 6"-8" remained green, and in this the moulds developed. Below this level, after only 24 hours, a change of colour was observed which progressed until all trace of green had disappeared, and the brown colour of finished silage was evident.

A more satisfactory method of preparing silage was found in the use of museum jars, with ground glass flanges. The jar is filled with chopped maize which is tamped down, and the cover luted on to the jar, giving an airtight joint. No visible growth of mould occurred in these jars, and the gradual transformation of green maize into brown silage could be followed from day to day.

In the largest size jar used (about 1 gallon) the maximum temperature did not rise above 37°C. in three weeks. The laboratory temperature during this period was 31°C.—34°C.

Examination of juice, extracted by macerating a portion of the ensiled material in a mortar, and expressing the juice through a cloth, showed that after only 24 hours there is an enormous development of lactic acid forming bacteria. These could not be obtained from cultures from material which had been ensiled for a period of 10-15 days. In the early stages yeasts also were abundant. Arrangements have been made to secure a continuous supply of maize, of the proper degree of ripeness, for the remainder of the growing season.

V. DAIRY BACTERIOLOGY.

Bacteriological examinations of the milk supplied by the Pusa Farm were made regularly throughout the year. The relation between the season of the year and the plate counts was again manifested. The average of the counts obtained in the months July—October 1925 was 38,500 bacteria per c.c. milk. The average count fell to 26,200 in November and to 9,250 in December.

The average counts for the six months January—June for the three years 1924-25-26 are as follows :—

	1924	1925	1926
January . . . . .	..	20,800	6,200
February . . . . .	..	8,300	6,900
March	8,300	11,500	7,700
April	5,600	28,200†	8,800
May	8,500	22,000	8,300
June	10,700*	28,500	11,100‡

* To June 18th before break of rains.

† Half of the month. Breakdown of the straw supply resulted in fluctuating, excessively high counts for the other half.

‡ No heavy rain in this month.

Thus the counts for the months March—June 1926 approximated closely to those for the corresponding months of 1924 and were far below those in 1925. Now in these months in 1924 and 1926 day temperatures were higher, and humidity lower than in 1925. Consequently the sterilizing agencies of sun and drought were more powerful in these years, and the counts show that fewer bacteria were brought into the milk by dirt from the bodies of the cows.

The high average count of 38,500 in the rains in 1925 approximates to the counts obtained in the previous year. The rains for 1926 had not started by June 30th, and so the expected sharp rise in the counts had not occurred by that date. When comparing these counts with those obtained

elsewhere, it must be particularly noted that at Pusa "sanitary" or "covered" milk pails are not used. Were these used, it has been shown here that the plate counts could be expected to be reduced to one-fourth of those obtained at present.

VI. E. C.

The supply of E.C. to the hospital and dairy at Pusa, Muzafferpur and Laheria Sarai hospitals, and Bihar jails was continued throughout the year.

A new type of graphode cell for the manufacture of E.C., made by Messrs. Mather and Platt, Ltd., was tested. It was found that after a few trials in which lime had not been added to the brine before electrolysis, corrosion of the cathode took place. This corrosion of the cathode which had not been noticed before, introducing fine particles of carbon into the brine, was accompanied by low concentration of available chlorine in the product. When lime was added to the brine before electrolysis, further disintegration did not take place.

VII. PHOTOGRAPHY.

Cinema films of agricultural subjects were prepared during the year. A selection of these films was shown to the members of the Board of Agriculture during the meeting of the Board at Pusa, to give them an opportunity of judging the utility of the cinema in illustrating the work of the Agricultural Department. The film on dairying was shown at Patna and Bangalore also.

Charge of the photographic department of the Institute was handed over to the Joint Director on 1st May, 1926.

VIII. MISCELLANEOUS.

Plant diseases. Specimens of maize showing a leaf spot, and tobacco with leaf curl were examined. In neither case could the disease be ascribed to bacteria. The tobacco disease appeared to be the one described some years ago from German East Africa, due to physiological disturbances in the seedlings caused by excessive moisture in the seed bed.

Further attempts to produce wilt in betel-vine by inoculation were unsuccessful.

Parasitology. Microtome preparations of house-fly tissues were prepared for the Director of Public Health, Bihar and Orissa, and the technique of the operation was shown to one of his assistants.

Ghee. Examination of samples of rancid *ghee* showed that bacterial action was not associated with the rancidity.

IX. PROGRAMME OF WORK FOR 1926-27.

During the current year the investigations now in progress, which have been reported on, will be continued. Special attention will be devoted to the subjects of soil nitrogen, phosphate solubilization, and silage.

X. PUBLICATIONS.

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|--|-------|---|
| Hutchinson, C. M. | . . . | Photography from the Microscope. <i>Indian Jour. Med. Res.</i> Vol. XIII, No. 3, January 1926. |
| Ditto | . . . | Causes of infertility in Soils in relation to Bacterial Action. <i>Agri. Jour. of India</i> , Vol. XXI, Pt. II, March 1926. |
| Ditto | . . . | Summary of Progress of Research in Agricultural Bacteriology in India for 1925-26, for the Committee of the Privy Council for Scientific and Industrial Research. |
| Hutchinson C. M., and
Ram Ayyar, C.S. | | Loss of sugar by inversion in Sugar Factories in Northern India and its prevention by Antiseptic Measures. <i>Pusa Agri. Res. Inst. Bull.</i> 163. |

REPORT OF THE IMPERIAL MYCOLOGIST.

(W. McRAE, M.A., D.Sc., F.L.S.)

I. CHARGE AND ESTABLISHMENT.

Mr. M. Mitra was in charge of the Section till 22nd November, 1925, when I returned from leave. From 4th May, 1926, I acted as Joint Director in addition to my own duties. The post of Second Imperial Mycologist was still held in abeyance. During the last four months Mr. M. Mitra was on leave and Mr. S. N. Mitra officiated in his place. Fieldman Md. Taslim acted as an Assistant for four months, and Mr. K. M. Dutt was appointed as clerk on 17th February, 1926.

II. TRAINING.

Three students are undergoing a post-graduate course, one in the second year and two in the first. Two students from the Institute of Animal Husbandry and Dairying, Bangalore, received a short course.

III. DISEASES OF PLANTS.

(1) *Wilt of Cajanus indicus, rahar, caused by Fusarium vasinfectum.* This year again there was little wilt till towards the end of the season when, however, it developed rapidly, but on the whole the attack was not severe. The numbers of wilted plants in the fourteen permanent manurial plots are in general accordance with those of previous years except in plot IV, the farmyard manure plot that gets the heaviest dressing, and in plot XVI, the green-manure and superphosphate plot. The average number of wilted plants in the three plots that get superphosphate, viz., plots VIII, IX and X, is four times that in the five plots that get no superphosphate, viz., plots I, XIII, XIV, VI and VII. In the farmyard manure plot mentioned above the number of wilted plants has gra-

dually increased year by year till it is now seven times the average of the five plots, and in the green-manure and superphosphate plot the number of wilted plants has suddenly soared up till it is six times that of the average of the five plots. It seems that, as hitherto hoped, green-manure does not always reduce the wilt in a plot manured with superphosphate. These results emphasize the necessity of continuing field experiments for a long time in order to get sufficient data from which to draw reliable conclusions.

The record of the wilted plants for the last nine years in both series of the permanent manurial plots is given below in tabular form :—

Wilted rahar plants on the permanent manurial plots at Pusa.

Plot	Manures supplied per acre	A SERIES						B SERIES				
		1918-19	1920-21	1922-23	1924-25	1917-18	1919-20	1921-22	1923-24	1925-26		
I	No manure	381	172	725	380	129	47	37	78	16		
	{No. of wilted plants	..	..	17-8	12-9	..	..	1-3	1-6	0-5		
	{Percentage of wilted plants	..	..	..	..	..	..	..	..	..
II	Farmyard manure to supply 10 lb. nitrogen	445	302	683	411	126	76	71	172	74		
	{	..	..	17-0	10-6	..	..	2-8	3-7	2-0		
III	Farmyard manure to supply 20 lb. nitrogen	307	216	537	340	319	250	275	486	287		
	{	..	..	12-7	8-7	..	..	11-7	11-4	8-0		
IV	Farmyard manure to supply 30 lb. nitrogen	478	441	1,210	586	703	760	886	1,551	902		
	{	..	..	35-6	15-6	..	..	37-5	39-0	28-9		
V	Rape seed to supply 20 lb. nitrogen	153	96	531	367	141	253	216	320	177		
	{	..	..	23-6	11-2	..	..	10-3	9-1	6-0		
VI	Sulphate of ammonia to supply 20 lb. nitrogen	117	93	394	193	346	360	248	482	208		
	{	..	..	12-4	6-1	..	..	10-3	11-4	6-5		

VII	Sulphate of potash to supply K_2O as in farmyard manure No. III.	{ 154 }	99	543	177	588	393	365	521	164
		..	..	15.3	4.9	..	..	17.2	12.1	4.7
VIII	Superphosphate to supply P_2O_5 as in farmyard manure No. III.	{ 698 }	995	1,849	1,003	1,903	1,452	898	1,408	687
		..	..	54.7	27.8	..	..	47.0	35.8	20.0
IX	{ Sulphate of potash to supply K_2O as in No. III . Superphosphate to supply P_2O_5 as in No. III .	{ 1,035 }	1,128	2,236	1,131	2,354	1,222	718	1,006	421
		..	..	68.8	32.3	..	..	37.8	28.4	11.4
	{ Sulphate of ammonia to supply nitrogen as in No. III. Sulphate of potash to supply K_2O as in No. III . Superphosphate to supply P_2O_5 as in No. III .	{ 1,017 }	1,014	2,734	1,356	1,814	989	719	874	345
X		..	..	88.5	43.1	..	..	40.3	21.6	11.0
XIII	Deep rooted leguminous crop (<i>rahar</i>) in a cereal rotation.	{ 311 }	237	604	217	233	252	141	281	93
		..	..	16.8	6.0	..	..	7.1	6.1	3.8
XIV	One deep (<i>rahar</i>) and one shallow rooted (peas) leguminous crop in the rotation.	{ 189 }	93	343	161	386	415	215	335	169
		..	..	11.4	4.5	..	..	11.3	7.2	5.1
XV	A leguminous crop and green manure in the rotation	{ 82 }	32	85	35	111	189	66	150	143
		..	..	2.6	1.1	..	..	3.9	6.2	5.0
XVI	Green-manure and superphosphate to supply P_2O_5 as in No. III.	{ 99 }	124	698	411	511	642	387	600	823
		..	..	17.6	14.8	..	..	24.8	25.0	31.2

To test the lateral spread of the disease through the soil in unmanured land and in land manured with superphosphate, five plots were laid down. In one plot of unmanured land a solid block of ten rows at one end was infected, while the lateral spread into eleven other rows was recorded. The ten rows had 92, 83, and 100 per cent. plants wilted in three successive years, while into the rest of the plot the disease spread regularly giving 9, 43 and 88 per cent. of wilted plants in the respective seasons.

Year	ARTIFICIALLY INFECTED			NOT SO INFECTED		
	No. of plants	No. of wilted plants	Percentage of wilted plants	No. of plants	No. of wilted plants	Percentage of wilted plants
1923-24 . .	319	294	92	352	33	9
1924-25 . .	320	265	83	352	154	43
1925-26 . .	320	320	100	352	310	88

Now the wilted plants are confined to the middle of one side of the plot at the far end. The land was hand-cultivated, great care being taken not to move the soil laterally. The spread of the disease was gradual and regular, both in space and in numbers.

In two pairs of plots of a quarter of an acre each, one with superphosphate and one without, a line of infective material was placed along the middle. The following is the record for the three seasons. There were 1,230 places for plants in each plot. The difference between that and the numbers of plants given in the table is due to lack of germination and to deaths from other causes.

Year	UNMANURED			SUPERPHOSPHATE		
	No. of plants	No. of wilted plants	Percentage of wilted plants	No. of plants	No. of wilted plants	Percentage of wilted plants
1923-24 . .	1,222	Plot 1 0	0	1,223	Plot 2 1	0.08
1924-25 . .	1,203	50	4.1	1,210	77	6.3
1925-26 . .	1,186	196	16.5	1,191	262	21.9
1923-24 . .	1,219	Plot 3 0	0	1,220	Plot 4 1	0.08
1924-25 . .	1,187	54	4.5	1,197	42	3.5
1925-26 . .	1,136	325	28.6	1,121	795	70.9

In one pair, plots 1 and 2, the difference in the amount of wilt between the no-manure and the superphosphate treatment is very little, while in the other pair, plots 3 and 4, it is substantial. The numbers and the position of the wilted plants in these plots show that a line of infective material is too precarious an infection, that a block of infective plants is required and that under farm conditions of cultivation the infection is spread through the soil mechanically in an irregular manner. This part of the investigation will be renewed in the light of the facts now known.

The Imperial Agriculturist very kindly sowed with disinfected seed 28 quarter-acre plots that had not had *rahar* since 1908. The average number of wilted plants in the whole area was 0.3 per cent. varying from no wilt to 3 per cent. In comparison with 30 quarter-acre plots grown last season on the farm land on which *rahar* is in the rotation every third year and on which the average number of wilted plants was 8 per cent. varying from no wilt to 31 per cent., this series of plots shows clearly that the great bulk of the infection comes from the fungus in the soil and not from spores borne on the seed.

The moisture content and the pH of every three inches down to two feet was taken throughout the growing season with results similar to those of last year. It is becoming apparent that, though the amount of moisture in the soil has no direct relationship to the amount of wilt, the retentive nature of the soil has something to do with it. Where water stands for a short time during rain, there wilt is worst. The result of the experiment which has for its object the isolation of a type of *rahar* resistant to wilt disease will be found in a joint report with the Imperial Economic Botanist on page 208.

(2) *Mosaic disease of sugarcane* was found a second time in Pusa, the previous occasion being in 1921. Its presence in North Bihar was suspected during last year and it was cautiously mentioned in the annual report. A search in Bihar and in some of the experimental stations in the United Provinces, Bombay, Punjab and Madras revealed its presence on several varieties. On word being sent to other mycologists, the

disease was found also in the Central Provinces and Burma. The disease has been found on the following canes :—

Bihar. Pusa (New Area)—Co. 205, Co. 210, Co. 213, Co. 232, Co. 248, Co. 250, Co. 275, Co. 281, Co. 282, Co. 286, Co. 287, Co. 288.

Pusa (Silk House Area)—Co. 205, Co. 213, Co. 281, Co. 286, Co. 287, Co. 288.

Pusa (Farm)—Co. 213.

Sabour Agric. Station—Co. 213, Red Mauritius.

Various estates—Co. 210, Co. 213, Co. 232, Hemja.

United Provinces. Aligarh Agric. Station—Co. 213, Co. 232.

Bulandshahr Agric. Station—Co. 213, Co. 232, Co. 281.

Kalai Dem. Farm—Co. 213, S. 48, B. 6308, Mauritius 16.

Punjab. Gurdaspur Agric. Station—Co. 210, Co. 231, Co. 232, Co. 242, Co. 247, Co. 257, Co. 258, Co. 261, Co. 265, Co. 270, B. 6308, B. 6388, S. 48, A. 2.

Madras. Palur Agric. Station—Mauritius 55, B. 147, B. 208, D. 1135, Fiji B, Java-Hebbal, Chittoor-Poovan.

Samalkota Agric. Station—J. 247, B. 208, B. 254, D. 625, D. 1135, A. 95, Purple Mauritius, Red Mauritius.

Coimbatore Central Farm—Java-Hebbal, Vellai, Poovan, Co. 1.

Bombay. Manjri Agric. Station—Java 33 A, Java 36, Red Mauritius.

Central Provinces. J. 213, Co. 203, Khari.

Burma. J. 213, J. 33 A, B. 376, D. 74, Striped Mauritius, Purple Mauritius, Java-Hebbal and Gilman Red.

Only the leaf-mottling is present : other secondary symptoms have not been seen. Leaves sent to Java and Hawaii were diagnosed as having unmistakeable symptoms of mosaic. Many Coimbatore canes are on the list, and in the majority of cases these were being grown only in very small trial plots and were but slightly infected, sometimes indeed only one clump being infected. In Pusa where the plots have been under continuous observation, Co. 232 is the only Coimbatore cane that is fully infected. Co. 250 has up to twenty per cent., Co. 287 fifteen per cent., Co. 210 and Co. 213 have five per cent. of clumps infected, while all the other have very few mosaic canes. One plot of Co. 213, however, short-planted in October to multiply seed quickly had nearly ten per cent. of the clumps infected. Co. 232 was also fully infected in the other stations where it was examined. Co. 213 and Co. 210 are canes that are being grown on a large scale in Bihar, but the loss in crop due to mosaic is not apparent. So far the infected canes do not seem appreciably smaller than the healthy ones. Co. 214, the other cane of this class grown on a field scale here, has not been observed to have mosaic. No mention has been made of the Coimbatore canes of which there is a considerable number that have not shown mosaic markings, as we do not yet know whether the absence of symptoms is due to lack of the chance of infection or to resistance.

Of the thick canes examined, Red Mauritius, Purple Mauritius, Maur. 16, B. 6308 and A. 2 were always fully infected. Hemja, the local cane in Bihar, is heavily infected throughout Northern Bihar. It is very stunted and will produce a light yield of cane. There can be little doubt but that a large part of the loss is due to the effects of mosaic. Comparative plots have been planted to test the loss in three varieties. The new crop was planted under supervision and is being rogued regularly to test the possibility of eradication of the disease. It is too early yet to say more than that the method promises well, and so far this is the method found to be applicable in other countries that have to deal with this problem.

In the varieties Co. 205, Co. 213, Co. 232, Co. 250, Co. 281, Co. 287 and Red Mauritius, sets from plants having mosaic

leaf-mottling have developed new plants that have identical leaf-mottling. Expressed juice from a mottled leaf of Co. 213^{*} pricked into leaves of Co. 213 produced mottling. These plants into which the juice was pricked had had no mosaic mottling during three seasons. The same happened from Red Mauritius to Co. 213. The mottling in Red Mauritius is far more conspicuous than in Co. 213 and this character became also apparent in the infected leaves of Co. 213. It may be that the "virus" is differentiated in the two varieties of cane or that the varieties react in different ways to the "virus."

In December, 1925, L. S. Subramaniam, the assistant who went to Aligarh and Gurdaspur to search for the presence of mosaic, found on the leaves of Uba canes in both places an appearance very like that described as streak disease by Storey* in Natal. Sets of Uba from Aligarh were planted in February in Pusa and by June one clump had developed symptoms exactly like those of streak disease. Over the whole surface of the leaf occurred numerous narrow, pale stripes running in the direction of the veins of the leaf. Each stripe was a quarter to half a millimetre in breadth and nearly uniform, while in length it varied from half a millimetre to a centimetre or more. They showed up most clearly in the newly expanded leaves. The juice of the leaves of this plant was then pricked into varieties of sugarcane and maize, but it is as yet too soon to expect results.

The fungus on the roots and bases of canes suffering from root disease last year in the district was determined by the Director, Imperial Bureau of Mycology, as *Hendersonina Sacchari* Butl. Infection experiments with this and other fungi from the same source were all unsuccessful. The flooded conditions that induced the disease in the previous year were not present this year and there have been no reports of root disease from Bihar.

(3) *Cotton*. At the request of Special Cotton Mycologist, Bombay, the temperature relationship of the cotton wilt fungus, *Fusarium* sp., was undertaken by Mr. M. Mitra. The

* Storey, H. H. Streak disease of sugarcane. *Dept. Agri. Union of South Africa, Sci. Bull.* 39, 1925.

fungus was grown at 20°C., 25°C., 30°C., 35°C., and 40°C., on both agar and liquid media.

I. Growth on agar medium—

The composition of the medium was :—

	gram.
Agar—agar	15
Glucose	20
Peptone	10
Sodium chloride	5
Libby's meat extract	4
Distilled water	1,500 c.c.

Fifteen c.c. of the medium were put in each of 40 petri dishes selected for uniformity. Spores of the fungus from a sub-culture grown at laboratory temperature (about 20°C.) were shaken in 5 c.c. of sterile distilled water in a test tube. A loop of this was placed on the agar in the middle of each petri dish, care being taken to have as far as possible the same amount of inoculum in each dish. Eight petri dishes were kept in incubators at each of five temperatures for six days and three diameters were measured, each 120° from the other.

	mm.
At 20°C. the average growth after six days was . . .	43.7
25°C. " " " " . . .	61.0
30°C. " " " " . . .	58.0
35°C. " " " " . . .	7.5
40°C. " " " " . . .	0.0

The eight petri dishes that had been kept at 40°C. were left at laboratory temperature for a week but no growth took place. The maximum growth was thus between 25°C. and 30°C. and the thermal death point near 40°C.

II. Growth on liquid medium—

The composition of the medium was :—

	gram.
Potassium acid phosphate	5.0
Potassium nitrate	10.0
Magnesium sulphate	2.5
Recrystallized cane sugar	34.3
Ferrous sulphate	Trace
Distilled water	1,000 c.c.

Fifty cubic centimetres of the solution were put into each of eighteen 200 c.c. Jena glass flasks selected for uniformity. Spores of the fungus from a sub-culture grown at laboratory temperature (about 20°C.) were shaken in 5 c.c. of sterile distilled water in a test tube. A loop of this was placed in each flask, care being taken to have as far as possible the same amount of inoculum in each flask. The flasks were kept at a constant temperature in an incubator. A group of three flasks was removed at regular intervals and the fungus within each flask was filtered, washed and dried to a fairly constant weight. The dry weight in grammes is given for various temperatures.

	13-14°C.	20°C.	25°C.	30°C.	35°C.	40°C.
4th day	0	0.005	0.020	0.060	..	nil
6th day	0	0.036	0.080	0.082	0.009	nil
8th day	0.005	0.056	0.142	0.115	0.024	nil
10th day	0.009	0.081	0.195	0.167	0.054	nil
12th day	0.016	0.107	0.419	0.199	0.069	nil
14th day	0.044	0.123	0.427	0.250	0.088	nil

The 18 flasks incubated at 40°C. were afterwards left on the laboratory bench, but did not show any growth after six days. The maximum growth was between 25°C. and 30°C., and the thermal death point near 40°C.

(4) *Cinchona*. Ten fungi were isolated last year from diseased cinchona in Sikkim plantations. Inoculation experiments were carried out at Mungpo with a view to determine the parasitic nature of these isolated fungi, but so far no infections have been obtained. The fungi are being maintained in culture for further inoculation experiments.

(5) *Trifolium alexandrinum* (Berseem). Inoculation experiments with *Rhizoctonia* sp., *Vermicularia* sp., and a *Fusarium* on berseem were repeated by Md. Taslim. The results obtained agree with those of last year, and it was found that *Rhizoctonia* sp. only could infect with success and was able to kill a large number of the plants inoculated, viz., 126 out of

176, i.e., 71 per cent. Seedlings have been found to be more susceptible to the disease than older plants. It was cultivated on many culture media and the morphology studied. The description agrees with that of *R. Solani* Kühn. Thus *R. Solani* Kühn causes the stem rot of berseem in Pusa.

(6) *Gram wilt*. In order to study the varieties resistant and susceptible to wilt disease presumed to be caused by *Fusarium* sp., 25 types (Types¹ No. 1—No. 25) that are grown in the Botanical Area at Pusa were tried. Seeds used for sowing were sterilized with 0.5 per cent. formalin for half an hour. Fifteen pots were used for each type of gram and six seeds were sown in each pot. Out of these 15 pots, five were kept as control; in three pots infection was made when the plants were 4" high by infected material from the last year's crop, in two pots by a fresh culture of the fungus; in three pots the seeds used were infected by mixing them with a culture containing plenty of *Fusarium* spores and the remaining two pots were filled with soil from a place where wilted plants occurred in the previous year. All the plants that wilted were removed and examined as soon as they were found dead. Only in the pots of last year's infected soil did wilt appear. In no case has infection of a gram plant been brought about by a culture of the fungus. Out of the 25 types, types Nos. 12, 15, 16, 19, 21, 22, 23, 24 were found to be free from the disease as no case of wilt occurred in any of the pots. The rest were found to be susceptible to the disease. Types No. 6 and No. 9 gave 80 per cent. wilted plants in the pots with the previous year's infected soil. Types Nos. 1, 2, 3 gave 50 per cent. wilted plants, and in the rest wilting was less than 20 per cent. It is proposed to repeat the experiment again in the coming cold weather.

(7) *Linseed wilt*. The study of linseed wilt caused by *Fusarium lini* was continued by Mr. S. N. Nanjundiah, a post-graduate student. The parasitic nature of the fungus was determined by conducting infection experiments on seedlings

¹ Howard A., Howard G. L. C., and Rahman Khan A. Some Varieties of Indian Gram. *Mem. Dep. Agri. India, Bot. Ser.*, VII, pp. 230-233, 1915.

of a susceptible variety of linseed (Type No. 70).¹ The soil of ten pots was infected with a culture of the fungus and seeds disinfected with 0.25 per cent. formalin were sown. Five pots were kept as control. Ninety-six plants wilted out of 96 in the ten pots, while one plant wilted out of 40 in the controls. Another experiment was carried out in pots of sterilized soil with cultures freshly obtained from wilted plants and cultures one year old. Wilting occurred in 58 plants out of 58 in those pots in which soil was infected with cultures recently obtained, whereas in pots infected with one year old culture 10 plants wilted out of 97 in the pots. This shows that a culture loses some of its power to infect when grown for a long time in artificial media.

The morphology of the various cultures from various sources was studied but all seemed to be of the same strain. The temperature relationship of the growth was studied by means of the petri dish method. The maximum growth lay between 25°—30°C. and the thermal death-point is near 37° or 38°C.

In order to ascertain the varieties resistant or susceptible to wilt, 16 varieties of linseed that are grown in the Botanical Area, Pusa, were taken, and the experiment was carried out on the lines of the gram wilt experiment just mentioned. Wilting occurred only in pots containing infected soil of the previous year, and it was observed that all the types tried are susceptible to the disease except type No. 121¹ and the Sabour variety: the latter, however, seems not to be botanically a pure type.

(8) *Mustard smut*. Smut on mustard was observed for the first time in 1921 in a small plot in a village near Pusa. The mustard crop in this plot had an unhealthy growth and formed a small quantity of seed. Upon up-rooting the plants, it was found that galls were adhering to the roots and some of these galls were 1" to 1½" in diameter and in appearance looked like a potato tuber. They were identified as *Urocystis corraloides*, a very rare fungus. Several attempts to get the spores to germinate proved unsuccessful.

¹ Howard G. L. C., and Rahman Khan A. Studies in Indian Oil Seeds, No. 2, Linseed, *Mem. Dept. Agri. India, Bot. Ser.*, XII, pp. 170-179, 1924.

The fungus appears only in that particular plot year after year and has not been found on any other mustard plot in the vicinity. In 1923 soil was obtained from that plot and put in 15 pots and sown with mustard seeds. All plants in the 15 pots got smut galls on the roots. These pots were kept, and in 1924 last year's experiment was repeated with the same results. In 1925 (November) the following infection experiment was carried out :—

- (a) In 20 pots containing infected soil of previous year mustard was grown.
- (b) Mustard was also grown in 15 pots, after infecting the seeds with spores of the fungus.
- (c) In 15 pots the soil of which was infected with spores of the fungus seeds were sown, and (d) 15 pots were kept as control.

All the plants in (a) 20 pots containing infected soil produced smut galls on the roots, while in the series (b) and (c) no sign of infection was observed.

(9) *Helminthosporiose*. The parasitic nature of a species of *Helminthosporium* on ginger and one on *Panicum frumentaceum* was tested again this year, and it was found that both of them can infect their respective hosts. Cross inoculations show that ginger *Helminthosporium* can infect *Eleusine coracana*, *Panicum frumentaceum* and *Setaria italica*. *Panicum Helminthosporium* can infect *Eleusine coracana*, *Setaria italica* and *Zea Mays*. The morphology of both species was studied in culture and concluded.

(10) *Phytophthora*. A comparative study of *P. Faberi*, *P. palmivora* and *P. Meadii* was continued.

(11) *Cucurbitaceæ*. The study of a fruit rot disease of various *Cucurbitaceæ* caused by a species of *Pythium* was concluded. The results of cross-inoculation experiments and morphological study in culture show that it agrees with *P. aphanidermatum* and is closely allied to *P. Butleri*.

(12) *Wheat*. A species of *Pythium* isolated from diseased wheat plants received from Dharwar, associated with "foot rot" of wheat, was studied.

IV. SYSTEMATIC WORK.

One hundred and three specimens were added to the herbarium from within and outside India. Specimens for training of students were supplied to the Allahabad University, Islamia College, Peshawar, the Mycologist, Nagpur, and the Economic Botanist, Lyallpur. *Phyodermma Zea Maydis* on maize found by Dr. Shaw in 1910 in Duars, Bengal, appeared in abundance for the first time in Pusa during the last rains, and *Helminthosporium turcicum* hitherto occurring in small quantity was epidemic on this crop. The uredo stage of *Puccinia Kuehnii* (Kreug.) Butl., similar to that found on *Saccharum spontaneum*, was found on Co. 213 in Pusa. *Spacelotheca cruenta* (Kühn) Pott. on *Sorghum vulgare* was also recorded from Peshawar valley. *Mycosphaerella pinodes* (B and Bos) Niessl that causes blight of gram was observed first in 1911 in North-West Frontier Province, and has again this year been found in Lyallpur. Specimens of coconut palms sent from the Andaman islands revealed the presence of *Botryodiplodia* sp. on this palm in these islands. A supplementary list of specimens in the Mycological Herbarium, Pusa, will be issued shortly.

V. PROGRAMME OF WORK FOR 1926-27.

1. *Research work.* New diseases of Indian crops that come to the notice of the Section will be investigated. The following crop diseases will receive special attention :—

- (a) Diseases of cereals.
- (b) Diseases of sugarcane.
- (c) Diseases of *rahar* (pigeon-pea).
- (d) Diseases of gram and linseed.

2. *Training.* Students and assistants will receive training on the lines indicated in the prospectus.

3. *Routine work.* Advice and assistance as required will be given to other departments and the general public.

VI. PUBLICATIONS.

- McRAE, W. Report of Mycology, 1925-26, for the Committee of the Privy Council for Scientific and Industrial Research.
- Ditto Mosaic Disease on Sugarcane in India in 1925. *Agri. Jour. India*, Vol. XXI Part III.

REPORT OF THE IMPERIAL ENTOMOLOGIST.

(M. AFZAL HUSAIN, M.Sc., M.A.)

I. ADMINISTRATION.

Mr. M. Afzal Husain held charge of the Section throughout the year, Mr. T. Bainbrigge Fletcher being away on leave.

Mr. P. V. Isaac, Second Entomologist (Dipterist), was on leave on average salary for 2 months and went abroad on combined leave for 6 months and 14 days with effect from 26th March, 1926.

The services of Rai Bahadur C. S. Misra, First Assistant to the Imperial Entomologist, have been placed at the disposal of the Indian Lac Association, for a period of 3 years, with effect from 2nd January, 1926.

Mr. G. R. Dutt, Personal Assistant to the Imperial Entomologist, has been appointed Offg. First Assistant.

The Section was understaffed throughout the year. The new Assistants appointed in place of officers transferred or on long leave have been under training, and it is hoped will prove useful additions to the staff.

II. TRAINING.

The following students received training during the year under review :—

- (1) S. Mukerjee, M.Sc., post-graduate student, was admitted in November 1923 and finished his course on 19th September, 1925.
- (2) Devraj Puri, B.Sc., student of the Punjab University, worked on *Rhopalocera* (7th—29th July, 1925 ; short-course student).
- (3) Karam Singh, M.Sc., student of the Punjab University, worked on the malpighian tubules of insects (7th July to 7th September, 1925 ; short-course student).

As the Entomologist to Government, Punjab, was transferred to Pusa, and the Entomologist to Government, U. P., went out on leave to England, the following four Indian Central Cotton Committee scholars were sent to Pusa for training and research :—

- (4) Kidar Nath Trehan, M.Sc., worked on the life-history of *Mylocerus maculosus* (5th August, 1925, to 20th March, 1926).
- (5) Vishwa Ram Singh, L.Ag. (Systematic Entomology : 1st December, 1925, to 31st May, 1926.)
- (6) H. D. Nangpal, M.Sc. (Systematic Entomology : 3rd January to 31st May, 1926.)
- (7) S. S. Bindra, M.Sc. (Systematic Entomology : 12th January to 22nd April, 1926.)
- (8) R. N. Mukerjee M.Sc., short-course student in Systematic Entomology ; admitted 13th May, 1926.
- (9) E. Heber, Artist of the Indian Lac Association, who was under training, finished his course on 28th October, 1925.

III. INSECT PESTS.

Observations on the pests of crops, vegetables and fruit trees were continued, and the following pests received special attention :—

Sugarcane borers. At the time of harvesting sugarcane, stubbles were collected and examined to ascertain the number of hibernating caterpillars. Out of 1,430 stubbles examined 101 hibernating caterpillars of *Emmalocera* were obtained. Similarly at the time of planting, sets for sowing were also examined for borers and out of 1,297 sets found attacked the following insects were secured :—

	Per cent.
<i>Diatraea</i> spp.	66
<i>Scirpophaga xanthogastrella</i>	16
<i>Emmalocera depressella</i>	2
Different parasitized caterpillars	16

It, therefore, appears that the caterpillars hibernating in stubbles are the main source of infestation of the next crop by *Emmalocera depressella*, and that *Diatraea* spp. and *Scirpophaga xanthogastrella* are sown by the careless farmer with his sets. The only other sources of infection are the alternative food plants, ratoon crops and crop of the previous year still standing in the field.

A cartload of sugarcane stubbles was buried in a pit and covered over with 6 inches of soil. The pit was opened in July, and it was found that the stubbles had all decayed.

The control measures which can be practised with good results in this country consist of safe disposal of stubbles, selection of insect-free sets, cutting down of the alternative food plants, and discouraging ratoon cane crops.

The experimental sowing of cane during October done by the Secretary, Sugar Bureau, is full of interest from entomological point of view, and the development of borers in this crop is being carefully studied.

Termites. Selected Coimbatore cane seedlings which were planted in November in the Botanical Area were badly attacked by termites. The usual methods of fumigating the soil with carbon-bisulphide and irrigating with water containing crude oil emulsion gave a very temporary relief. Finally, it was decided to attract termites to other foodstuffs and poison them. With this in view a trench 2 feet deep and 1 foot wide was dug all round the field. Different kinds of available dry twigs such as mango, deal, *sissu* (*Dalbergia sissoo*), jute, sann-hamp, etc., were placed in the trench to discover which was most liked by these insects. Jute sticks were finally selected, and steeped in a mixture of lead arsenate 20 ounces, molasses 4 lb. and water 40 gallons, and buried in the trenches. This measure shows possibilities of success, but no definite opinion can be expressed unless it has been tried for a few years during different seasons. The extreme severity of attack in the present instance may be traced to green-manuring. The problem of green-manuring requires a most careful study from the entomological point of view, as an addition of any organic matter to the soil provides food for

soil insects and makes an increase in their numbers a certainty. This is particularly true of termites.

Monophlebus sp. Excellent results were obtained in the control of the giant mealy bug by the use of sticky bands made in the laboratory. The upward march of the nymphs was arrested and they died in millions. Thousands made abortive attempts to cross the bands and got stuck. In every case the part of the trunk below the band was one mass of crawling insects, and the soil round the trunk of the tree was one seething mass of myriads of nymphs in layers 3 to 4 inches deep. To shorten their misery of slow death by starvation, and their spread to other trees in search of suitable foodplants, the nymphs were destroyed by spraying with crude oil emulsion. This very simple measure of banding the trees is the cheapest and most efficacious method of dealing with this pest of fruit trees, and an insect which is a serious nuisance when it invades dwellings.

Aphids on lentils. An experimental plot of the Imperial Economic Botanist under lentils was badly attacked by aphids. The bagged plants were the worst sufferers. Spraying and dusting being out of question, a biological method of control was tried. About 3,000 adults of *Chilomenes sexmaculata* were collected and liberated in this plot, and when the field was examined after 10 days not one aphid could be found.

Mango-hoppers (*Idiocerus atkinsoni* and *I. clypealis*). Spraying and dusting experiments against mango-hoppers were carried out to test the comparative value of various insecticides such as (1) crude oil emulsion, (2) fish oil rosin soap, (3) naphthalene, (4) road dust and carbolic acid, (5) tobacco waste, (6) tobacco waste with lime, (7) calcium cyanide dust "A," (8) calcium cyanide dust "S." Of these, the first six had no effect on the hoppers and calcium cyanide dust "A" and "S" were only effective. "A" gave most excellent results. The hoppers started dying within a few minutes of dusting. Four grafted mango trees of fairly large size were dusted with 16½ lb. of calcium cyanide dust "A" and the operation took 4¾ hours. The number of hoppers killed was roughly ascertained to be 200,000. In so far as small trees

are concerned, one can with an ordinary blower reach every part and kill the pests. With high trees there will be some difficulty. Calcium cyanide is certainly the most effective chemical for use against mango-hoppers, and its extensive use will depend on the price of the material and the availability of a suitable blower.

Brachytrypes portentosus was bad in an experimental sugar-cane plot of the Secretary, Sugar Bureau, and was successfully controlled by injecting petrol in the burrows.

Diacrisia obliqua was very bad on jute, *mung* (*Phaseolus mungo*) and *urid* (*Phaseolus radiatus*). It was checked by hand-picking of egg-masses and young larvæ which are gregarious in early stages.

Influence of cultivation on pest resisting power of plants.
It is commonly believed that sickly plants are more susceptible to attacks of insects than healthy plants, and consequently improvements in cultivation, which will result in healthy growth of plants, are considered to be the most potent of pest control measures. Like most common beliefs it only states half truth, and we are so far completely in the dark as to the relationship between pests and plants. For instance, does a sickly plant show a definite predisposition for insect pests and produces substances that act as attractants, or does it suffer simply because it does not possess sufficient "vitality" to outgrow the attack? To gain an insight into the true nature of this problem experiments were started with mustard which normally gets heavily infested with aphids. The Imperial Economic Botanist very kindly placed six lysometers at our disposal for this experiment and provided every possible facility. The help given is thankfully acknowledged. The object of the experiment was to discover the relationship between the incidence of attack and the condition of the crop grown in manured and unmanured soil, under different conditions—unirrigated, irrigated and water-logged. Three of the lysometers were filled with soil heavily manured with farmyard manure and the remaining three contained ordinary unmanured soil. The soil was well soaked with water in all the six lysometers on 21st November, 1925, and mustard sown in

lines on 25th November, 1925, there being the same number of lines in each lysometer. Afterwards in each of the manured and unmanured sets of three lysometers one was irrigated and drained, the other kept in a water-logged condition and the third left unirrigated. The experiment lasted from 25th November, 1925, to 14th March, 1926, and during this time there was only 76 cents of rain. In each lysometer the plants were thinned twice and the same number of plants was kept in each row. The final yield of seed, as given below, may be taken as an index of the condition of the crop and growth :—

	gram.
1. Manured, irrigated and drained	440
2. Manured, water-logged	295
3. Manured, not irrigated	272
4. Unmanured, not irrigated	63
5. Unmanured, irrigated and drained	58
6. Unmanured, water-logged	7.65

Regarding the incidence of attack it was noticed that the pest appeared simultaneously in all the lysometers, but some plants in each of the six lysometers were attacked earlier than the others. It was noticed that a plant with a larger number of leaves, branches, flowers and pods, and therefore in excellent condition of growth, had a much larger number of insects on it than a plant in poor condition, *i.e.*, with few leaves and fewer branches, etc. It may be said with certainty that the total mass of living material in the form of aphids was greatest in the lysometer which gave the highest yield.

It is too early to make a definite statement, but the experiment shows this quite clearly that a healthy mustard plant grown in a well-manured soil, properly irrigated and well drained, can withstand the attack of aphids much better than an "unhealthy" plant; but the "unhealthy" condition in itself does not appear to make the plant more attractive to the pest. It is likely that the relationship between mustard and mustard aphids is so well established that the pest derives its supply of food without causing any additional injury to its host, and therefore a plant which has an abundance of food

supply does not suffer. Another crop may behave differently and during "unhealthy" state may show definite predisposition towards a pest. This has to be established by actual experiments.

Work on these lines will be very fruitful, and a beginning has been made which it will be well-worth following.

Studies in oviposition response of insects. During breeding experiments it was observed that *Aulacophora abdominalis* and *Dysdercus cingulatus* oviposited on moist soil only. To discover whether atmospheric humidity provided stimulus for oviposition or moist soil was essential, observations were started. It was discovered that atmospheric humidity was not of any importance and the presence of moist surface was essential to excite oviposition. Eggs were deposited on wet sand, wet blotting paper and even on moist surface of glass, but not on dry sand or soil even when the atmosphere was fully saturated with water vapour.

Fumigation. So far no systematic study on the influence of fumigants on insects have been undertaken in this country, and our information is based on results achieved by American and European workers. Thus the doses recommended by these writers often fail to kill insects in this country. With a view to gain knowledge regarding this important question, experiments have been started to test the lethal effects of carbon bisulphide on *Bruchus chinensis* under varying conditions of temperature, humidity and duration of exposure. Preliminary tests have been made and the work will be continued.

Pathological Entomology.

Mr. P. V. Isaac, Second Entomologist, continued his work on the life-histories and distribution of Tabanidæ.

Mr. Sharif, of the Muslim University, Aligarh, worked in the Entomological Section for three weeks and studied the tick collection of the Institute.

Rinderpest transmission experiments were carried out by Mr. S. K. Sen at the Veterinary Research Institute, Muktesar, but instead of *Musca domestica*, the tick *Boophilus australis* was used. Ticks removed from experimentally

infected bulls, at the height of the disease, were crushed in normal saline solution under sterile precautions and the emulsion injected intravenously into healthy bulls. Infection resulted in one instance only. The possibility of hereditary transmission was also tested, by injecting saline emulsion of crushed eggs of infested ticks, and in few instances transmission was also attempted by transplanting on healthy bulls ticks removed from experimentally infected bulls. The results were all negative.

Flies became very common in the dairy during April, and we were asked to take steps to control them. Fly-paper prepared in the following manner gave excellent results: equal quantities by weight of castor oil and rosin were boiled together and to the prepared mixture half of its weight of molasses was added and well stirred, and sheets of thick paper painted with this.

Life-history work.—Breeding work was continued. It was found out that *Phthorimæa operculella* passed through 13 generations from July 1925 to 30th May, 1926. Very few moths emerged from the last generation and these died without laying eggs. The life-history of *Odontomyia cyanea*, a very common species of *Stratiomyidæ*, has also been studied.

Work has also been done in describing the early stages of some of the Psyllid pests of plants.

IV. BEES AND LAC.

Apiculture. Numerous enquiries regarding apiculture were dealt with. Comb foundations suitable for *Apis indica* were prepared for the Political Agent, Kurram Valley, and other interested persons. As judged from the number of letters received, there is a great demand for suitable varieties of honey bees, and some people are prepared to introduce foreign strains and experiment on their own. So far we have been advising against such an action, because through indiscriminate importation there is likelihood of introducing bee diseases into this country. The necessity of appointing a well trained

Apiculturist is very pressing. The bee industry should be placed on a sound footing, and strains suitable for various localities established under scientific supervision as early as possible.

Lac. The emergence of larvæ from the *Katiki* crop started from 19th October, 1925 ; the larvæ of the *Baisakhi* crop did not swarm till 4th July, 1926. Brood-lac was supplied to the Secretary, All-India Lac Company, Ltd., Calcutta, and to two other lac-growers.

Rai Bahadur C. S. Misra's services have been placed at the disposal of the Indian Lac Association, and it is expected that the training of students as well as supply of brood-lac will in future be arranged by this organization.

V. PEST ACT.

In connection with the measures undertaken to prevent the introduction of *Anthonomus grandis* (the cotton boll-weevil of America) into this country, the services of an Assistant (Mr. R. N. Mathur) were placed at the disposal of the Indian Central Cotton Committee. For two months the Assistant stopped in Bombay and carefully examined the bales of American cotton imported into India. The examination of the bales was carried on before fumigation, after fumigation, again on the wharf, and in a few cases when opened out in the mills. In all 12,615 bales were examined, of which 107 were opened out. Only a single crushed specimen of *A. grandis* was secured.

Mr. Mathur also examined other "living plants" that were imported during his stay in Bombay. These plants were being fumigated under the inspection of the Customs officers at the Parel Laboratory. So far no steps are being taken to keep a record of intercepted insects, and we are absolutely in dark as to what insects we are likely to find introduced into this country. Taking precautionary measures such as fumigation or prohibiting the importation of certain material, without definitely knowing what insects can reach the shores of this country alive and get footing here, is to say the least very uneconomic. Staff trained in entomology should be

employed at the ports to report on the insects coming in and every pest we wish to guard against must be studied. It will be much cheaper and productive of more good if money be spent on this than on fumigating dead insects.

VI. INSECT SURVEY.

A census of the named species in our collection was taken in 1918 and another has been taken this year. The comparative statement below shows the progress made.

	1908	1910	1918	1926
Hymenoptera	400	417	758	962
Diptera . . . . .	..	..	168	552
Lepidoptera	600	1,235	2,540	3,606
Coleoptera	650	1,236	1,939	2,470
Rhynchota	500	606	743	745
Neuroptera (sensus antiquo) . .	1	60	180	314
Orthoptera (sensus antiquo) . .	70	91	143	166
TOTAL .	2,221	3,647	6,471	8,815

Collections were sent out for identification to the following specialists and the help rendered by them is thankfully acknowledged :—

- (1) Mr. G. J. Arrow—Scarabæidæ (Coleoptera)
- (2) Capt. P. J. Barraud—Culicidæ (Diptera)
- (3) Mr. K. G. Blair—Coccinellidæ (Coleoptera)
- (4) Mr. G. E. Bryant—*Aulacophora* spp. (Coleoptera)
- (5) Mr. T. Bainbrigge Fletcher—Macros (Lepidoptera)
- (6) Mr. J. C. M. Gardner—Cerambycidæ (Coleoptera)
- (7) Mr. E. Ernest Green—Coccidæ (Rhynchota)
- (8) Herr R. Kleine—Lycidæ (Coleoptera)
- (9) Dr. G. K. Marshall—Curculionidæ (Coleoptera)
- (10) Mr. S. Maulik—Chrysomelidæ (Coleoptera)
- (11) Herr Ochs—Gyrinidæ (Coleoptera)
- (12) Mr. L. B. Prout—Geometridæ (Lepidoptera)
- (13) Miss A. E. Prout—Noctuidæ (Lepidoptera)

Various collections of insects were received for identification from Provincial Departments—Madras, Punjab and Bombay; the School of Tropical Medicine, Calcutta; the Bombay Natural History Society and private individuals, and named as far as possible.

Requests from foreign entomologists regarding supply of Indian insects were complied with and the following specimens were sent:—

- (1) *Idiocerus atkinsoni* and *Idiocerus clypealis*, to Mr. Whitehead, Ag. Entomologist, Truro (N. S. Canada).
- (2) Indian Honey Bees, to Mr. Mavromonstakis, 217, St. Andrews' Street, Limassol, Cyprus.
- (3) *Orectochilus gangeticus*, *Dineutus unidentatus*, to Herr G. Ochs, Germany.
- (4) Larval and pupal stages of *Hæmatobia nudinervis*, to Major Patton, Edinburgh.
- (5) Scale insects on Citrus, to Mr. Chaimberlain, California, U. S. A.
- (6) Examples of a Capsid bug (*Gallobelicus crassicornis*), to Dr. Pulmer, Medan.

A part of the Lepidoptera collection has been arranged in 20 cabinets and about 50 more will be required to accommodate the specimens in this group alone. The whole of the valuable collection of Coleoptera and Rhynchota is still kept in old store boxes.

VII. CATALOGUE OF INDIAN INSECTS.

The following parts of the Catalogue have been issued during the year:—

Part 6—Staphylinidæ, by M. Cameron.

Part 10—Stephanidæ, by G. R. Dutt.

Catalogues of Cicindelidæ and Brenthidæ have been completed and are ready for publication, and those of Carabidæ, Longicornia, Scolytidæ, Platypodidæ, Bostrychidæ, Anobiidæ, Coccidæ and Thysanoptera are under preparation.

VIII. PROGRAMME OF WORK FOR 1926-27.

Major.

This will follow generally on the lines of work of the current year and will include general investigations of crop pests and specially of the pests of sugarcane, rice and cotton, of fruit trees, and stored grain, and also work on insect pests of domestic animals.

Minor.

Results in various lines require to be written up and published as far as possible. New insecticides and insecticidal methods will be tested as occasion arises. Systematic work will be carried out with our resources, and the help of specialist correspondents. The Catalogue of Indian Insects will be proceeded with. Advice and assistance will be given as far as possible to Provincial Departments and to all inquirers on entomological subjects.

IX. PUBLICATIONS.

The following publications either prepared by the Pusa staff or founded in whole or part on material sent from Pusa have actually been issued during the year ended 30th June, 1926.

- DUTT, G. R. . . . The Giant Mealy Bug and its Control
(*Bull. Ent. Res.*, XVI, pp. 155—158,
tt. IX-XI; Oct. 1925).
Catalogue of Indian Insects, Part 10-
Stephanidæ; January 1926.
- FLETCHER, T. BAINBRIGGE List of Publications on Indian Entomology, 1924 (*Pusa Bull.* 161).
Migration as a factor in Pest outbreaks
(*Bull. Ent. Res.*, XVI, 177—181; Oct. 1925).
Tentative Keys to the Orders and Families
of Indian Insects (*Pusa Bull.* 162,
tt. I—IX; 1925).

- HUSAIN, M. AFZAL . . . Reduction of the loss (to Cotton) caused by Insects. (Paper read at the Indian Science Congress, Bombay, 5th January, 1925; published by the Indian Central Cotton Committee.)
The Red Pumpkin Beetle, *Aulacophora abdominalis*, Fb. and its control; with a short note on *A. atripennis*, Fb. (*Mem. Dept. Agri. India, Ent. Ser.*, IX, pp. 31—57, tt. XII—XIV; Feby. 1926).
- ISAAC, P. V. . . . Papers on Indian Tabanidæ, VIII. The Bionomics and Life-histories of some of the Common Tabanidæ of Pusa (*Mem. Dept. Agri. India, Ent. Ser.*, IX, pp. 21—28, tt. V—X).
Some observations on the Life-history and habits of *Phycus brunneus*, Wied. (Fam. Therevidæ) (*Loc. cit.*, pp. 29—30, t. XI).
The South Andaman Coconut Slug Caterpillar (*Thosea unifascia*, Wlk.) (*Agri. Jl. Ind.*, XX, pp. 373—379, t. XXVIII; Sept. 1925).
- MEYRICK, E. . . . *Exotic Microlepidoptera*, III, Pt. 5, pp. 129—160; Jan. 1925.
Exotic Microlepidoptera, III, Pt. 9, pp. 257—288; Feby. 1926.
- PROUT, L. B. . . . Geometrid Descriptions and Notes (*Nat. Zoo.*, XXXII, pp. 31—69; April 1925).
- UVAROV, B. P. . . . A revision of the genus *Ceracris*, Wlk. (Orthopt. Acrid.) (*Ent. Mitteilungen*, XIV, pp. 11—17; Jan. 1925).
- WITHYCOMBE, C. L. . . . A Contribution towards a Monograph of the Indian Coniopterygidæ (Neuroptera) (*Mem. Dept. Agri. India, Ent. Ser.*, IX, pp. 1—19, tt. I—IV; June 1925).

REPORT OF THE IMPERIAL AGRICULTURIST.

(ARJUN SINGH MAN, L.AG.)

I. CHARGE.

Mr. G. S. Henderson, N.D.A., N.D.D., Imperial Agriculturist, held charge of the Agricultural Section from 1st July, 1925 to 15th March, 1926, and then proceeded on seven months' leave from 16th March, 1926. I was put in charge of the current duties of the Imperial Agriculturist during the absence of Mr. Henderson on leave, in addition to my own, from 16th March, 1926.

Mr. Aga Mohamed Mustafa, B.A. (Oxon), joined the Section as Agronomist in the afternoon of 21st June, 1926.

Bhai Arjun Singh Man, L.Ag., was confirmed in the post of Assistant to the Imperial Agriculturist in Class II Service, and he'd it throughout the year except for 29 days from 2nd to 30th January, 1926, when he was on leave on average pay. Mr. Ali Murtaza, First Farm Overseer, acted as Assistant to the Imperial Agriculturist during the absence of Bhai Arjun Singh on leave.

Mr. L. S. Joseph, G.B.V.C.; F.R.C.I., Cattle Superintendent, was on leave from 24th February to 25th August, 1925, and Mr. S. M. Jamalluddin, Second Cattle Superintendent, officiated for him.

II. TOURING AND ADVISING.

In November 1925, Mr. Henderson visited Gauhati with the Director of Agriculture, Assam, to select a site for the proposed cattle-breeding station. He attended the Indian Science Congress as President of the Agricultural Section in January 1926. As a member of the Bara Farm Advisory Standing Committee, he attended in March 1926 a meeting of the Committee in the Punjab. Mr. Henderson also visited the Karnal Cattle Breeding Farm to give advice on cultivation and the cropping scheme of the farm.

A number of enquiries were attended to and advice given. These enquiries mostly related to cattle-breeding, fodder crops, tractors, silos and silage-making, agricultural machinery,

etc. Over a hundred maunds seed of best crop varieties and 1,050 maunds of sugarcane were distributed to about forty Government farms and private individuals.

III. TRAINING.

Two post-graduate students attended the course of training in general agriculture and cattle-breeding from 4th January to 31st March, 1926.

IV. PUSA FARM AND CULTIVATION.

Season. The total rainfall from June 1925 to May 1926 amounted to 48·67 inches as against 57 inches for the corresponding period of the previous year. The monsoon broke on 1st June with a fall of $\frac{1}{2}$ inch rain followed by similar showers at intervals, the total for the month amounting to 5·20 inches. *Kharif* sowings were started on 2nd June and continued throughout the month. The rainfall was fairly well distributed and the crop production was normal, except that 6·50 inches of rain on 3rd September and 3·27 inches on the following day accompanied by a storm made the maize crop, which was just forming cobs, to lodge and thereby reduced the yield to a half.

The prospects of *rabi* crops were not encouraging in the beginning owing to the failure of *hathia* rain, but $\frac{3}{4}$ inch rain on 9th January improved the situation considerably. Rain-fall figures are given below :—

	Rainfall in inches						
June 1925	5·20
July	9·31
August	16·29
September	15·43
October	0·17
November	0·17
December	nil
January 1926	0·86
February	nil
March	0·26
April	0·43
May	0·55
TOTAL	<u>48·67</u>

Field experiments. The permanent manurial and rotation experiments were continued as before. The figures of out-turn with details of treatment are given below :—

TABLE I.

Permanent manurial and rotation experiments for 1925-26.

Plot No.	Treatment	A SERIES		B SERIES			
		Maize grain in lb. per acre	Oats grain in lb. per acre	Peas grain in lb. per acre	Maize grain in lb. per acre	Arhar grain in lb. per acre	Barley gr. in lb. per acre
1	No manure	370	595	..	152	438	..
2	Farmyard manure to supply 10 lb. nitrogen per acre	501	780	..	252	1,090	..
3	Farmyard manure to supply 20 lb. nitrogen per acre	688	940	..	285	1,068	..
4	Farmyard manure to supply 30 lb. nitrogen per acre	862	1,164	..	392	890	..
5	Rape cake to supply 20 lb. nitrogen per acre	597	760	..	238	80	..
6	Sulphate of ammonia to supply 20 lb. nitrogen per acre	181	499	..	80	690	..
7	Sulphate of potash to supply K_2O as in farmyard manure No. 3	201	417	..	70	599	..
8	Superphosphate to supply P_2O_5 as in farmyard manure No. 3	450	1,143	..	222	772	..
9	Sulphate of potash to supply K_2O and superphosphate to supply P_2O_5 as in farmyard manure No. 3	416	1,127	..	265	821	..
10	Sulphate of ammonia to supply nitrogen, sulphate of potash to supply K_2O and superphosphate to supply P_2O_5 as in farmyard manure No. 3	542	1,199	..	345	772	..
11	No manure or leguminous crop .	107	521	..	96	..	468
12	Green manure in a cereal rotation .	..	567	..	152	..	591
13	Deep rooted leguminous crop in a cereal rotation	133	447	..	78	337	..
14	One deep and one shallow rooted legume in the rotation	162	361	82	119	230	..
15	Leguminous crop and green manure in the rotation	..	483	..	205	255	..
16	Green manure and superphosphate to supply P_2O_5 as in farmyard manure No. 3	..	1,256	..	374	460	..

The following experiments were continued under the direction of the Imperial Mycologist to deal with the wilt disease of the *arhar* plant (*Cajanus indicus*):—

TABLE II.

(a) *Permanent manurial plots in North Pangarbi.*

Plot No	Treatment	A SERIES	B SERIES	REMARKS.
		Oats in <i>rabi</i> 1925-26	Oats in <i>rabi</i> 1925-26	
		lb.	lb.	
1	Check (superphosphate)— P_2O_5 60 lb. per acre	2,864	2,874	A Series—fallow during <i>kharij</i> 1925.
2	Superphosphate— P_2O_5 20 lb. per acre	2,885	2,283	
3	Check (superphosphate)— P_2O_5 60 lb. per acre	2,402	2,341	B Series—Sann-hemp ploughed in during <i>kharij</i> 1925 for green-manuring.
4	$MgSO_4 \cdot 7H_2O$ (magnesium sulphate) 150 lb. per acre ; P_2O_5 (superphosphate) 60 lb. per acre	2,751	2,505	
5	Check (superphosphate)— P_2O_5 60 lb. per acre	1,776	2,464	
6	$MgSO_4 \cdot 7H_2O$ 300 lb. per acre ; superphosphate— P_2O_5 60 lb. per acre	1,725	2,382	
7	Check (bonemeal)— P_2O_5 60 lb. per acre	1,263	1,232	
8	$Fe_2(SO_4)_3$ (ferric sulphate) 150 lb. per acre ; superphosphate— P_2O_5 60 lb. per acre	1,458	2,217	
9	Check (superphosphate)— P_2O_5 60 lb. per acre	1,519	2,217	
10	$Fe_2(SO_4)_3$ (ferric sulphate) 150 lb. per acre ; superphosphate— P_2O_5 60 lb. per acre	2,053	2,299	
11	Check (superphosphate)— P_2O_5 60 lb. per acre	2,412	2,669	
12	$Fe_2(SO_4)_3$ (ferric sulphate) 150 lb. per acre ; superphosphate— P_2O_5 60 lb. per acre	2,607	2,361	
13	Check (superphosphate)— P_2O_5 60 lb. per acre	2,053	2,977	

(b) *Four plots in Punjab field, B Block.*

No. of plot	Treatment	Outturn of <i>rahar</i> per acre in lb.
1 B	No manure	912
2 B	4 cwt. superphosphate per acre	1,002
7 B	No manure	969
8 B	4 cwt. superphosphate per acre	526

TABLE II—*contd.*(c) *Four plots in Punjab field, D Block.*

No. of plot	Treatment	Outturn of <i>rahar</i> per acre in lb.
1 D	No manure	1,252
2 D	No manure	920
5 D	No manure	1,551
6 D	No manure	1,018

Green-manuring experiments for the Imperial Agricultural Chemist were continued during the year. The following are the details :—

TABLE III.

No. of plot	Treatment	Outturn of oats per acre in lb.
1	No manure	446
2	Green manure alone	878
3	Superphosphate— 50 lb. P_2O_5 per acre	801
4	Green manure and superphosphate—50 lb. P_2O_5 per acre	1,232
5	No manure	5
6	No manure	462

Outside the purely experimental area, the major portion of the unirrigated farm land is cropped under the simple rotation mentioned in previous years' reports for the production of food for the pedigree cattle herd. It forms a general fertility improvement experiment on a practical scale. The comparative figures of outturn from 1912-13 to 1925-26 are given below. The decrease noticeable under the column "green fodder" in Table IV is due to the major portion of the green crops, which

used to be cut and fed in, being now grazed to milch cows in the field. It has been observed that the daily milk yield of cows is more satisfactory when the animals are allowed to graze the green crop in the field than when the same is cut and fed in the byre.

TABLE IV.

Yield from 13 fields (413 acres) for the last 14 years.

Year	Annual rainfall	Oats and other cereals	Maize	Pulses	Total grain	Green stuff for fodder and silage
	Inches	Md.	Md.	Md.	Md.	Md.
1912-13 . .	41.26	2,210	522	894	3,626	16,301
1913-14 . .	61.74	1,997	500	1,100	3,297	11,513
1914-15 . .	54.88	1,749	534	704	2,987	14,427
1915-16 . .	51.37	2,669	884	701	4,254	36,903
1916-17 . .	59.67	2,897	670	932	4,499	31,971
1917-18 . .	45.54	2,376	1,276	1,010	4,662	30,893
1918-19 . .	60.19	3,386	559	1,037	4,982	30,735
1919-20 . .	32.73	2,479	1,064	719	4,262	31,624
1920-21 . .	44.33	2,542	766	1,073	4,381	33,359
1921-22 . .	39.82	3,754	1,267	1,132	6,153	34,492
1922-23 . .	65.78	3,752	496	941	5,189	23,021
1923-24 . .	24.88	2,448	988	1,100	4,536	29,146
1924-25 . .	57.00	5,816	467	1,234	7,517	20,936
1925-26 . .	48.67	4,611	343	1,030	5,984	22,906

Sugarcane. 7.25 acres of Co. 213 were grown on the farm. It yielded 525 maunds stripped cane per acre; out of this 1,050 maunds were distributed for seed. A larger area has been put down this year as there is a demand for seed of Co. 205.

Oats. The best yield of farm oats per acre obtained was 24 maunds from an area of 40 acres, and the average outturn per acre from 244 acres was 18.84 maunds as compared with 22 maunds per acre during the previous year. About 100 maunds seed of pure oats was distributed and the demand is increasing. The Scotch Potato oats which are under trial for a number of years are improving and getting acclimatized gradually. Four maunds seed of this variety was obtained

from an area of $\frac{1}{2}$ acre, which will be sown on a field scale next year.

Maize. Three pure types of this crop have been isolated by continuous selection and are grown pure on the farm. Seed is available for distribution now.

Berseem. The reclamation of the available area in the *dhab* has been completed. It is now about 130 acres on which green fodder only is grown under irrigation. Berseem was grown on 103 acres of this land in the cold weather. Sowing was started at the end of September and finished in the middle of October. A herd of 350 cattle was put on the crop in the middle of November and remained on berseem till the end of April. Eleven thousand maunds green berseem was available for cutting and feeding in the byre. The cattle were entirely on green maize which followed berseem and will continue till August 15th. Three thousand and two hundred maunds green maize has been cut and stored as silage.

The seed of this crop is imported from Egypt every year. Its production in India is of great importance as the cost of imported seed is high. Last year's 20 lb. seed was sown on $\frac{1}{3}$ acre plot and yielded 20 seers first class pure seed, that is, at the rate of $1\frac{1}{2}$ maunds per acre. About 6 acres were kept for seed this year and $2\frac{1}{2}$ maunds good seed was threshed out of it. If the progress continues like this and if we are able to get three maunds per acre, the whole question of seed production will have been solved.

Leguminous fodder crops. The common pulses *guar* (*Cyamopsis psoralioides*), *meth* (*Phascolus aconitifolius*), cowpeas (*Vigna catjang*), soybean (*Glycine hispida*) have established their value for feeding and grazing after a number of trials. There had always been a gap when there was no green grazing for the cattle in the months of October and November and the milk yield used to go down considerably. To fill this gap, 20 acres *meth* and 20 acres soybeans were reserved for grazing in October and November respectively. The result of this arrangement was that the milk yield remained normal (Table VIII). These pulses are sown at the break of the monsoon and are fit for grazing in the following order:—Guar—in

August, cowpeas—in September, *meth*—in October, soybeans—in November. Grazing of soybeans was demonstrated on a practical scale to the members of the Board of Agriculture in the first week of December last.

All crops are sown by means of seed drills which provide easy and cheap means of interculture. The seed drill in common use is the 11-row Monarch drill (Plate I). Sixteen plots of equal size were sown under wheat Pusa 52 with this drill and 12 plots of the same size with the country plough in collaboration with the Imperial Economic Botanist. The average yield from 16 drilled plots per acre was 1,480 lb. as against 1,223 lb. per acre sown with the country plough.

Silage. This is the most economical way of storing green fodder for the periods when succulent food is scarce. It is specially necessary for milk cows as it helps in keeping up a regular milk flow. Twenty thousand maunds green maize was turned into silage during the year under report and was stored in *kutch*a pit silos. The details of some of the pits are given in Table V.

TABLE V.

Showing details of some of the silo pits at Pusa.

Serial No.	Name of pit	Date of filling	Total green stuff	Period of consumption	Total silage consumed	Loss percentage
			Md.		Md.	
1	Eastern Chandman . . .	15-7-25 to 20-7-25	3,006	19-10-25 to 10-11-25	2,615	13
2	Northern Tara . . .	28-8-25 to 31-8-25	3,155	7-5-26 to 15-6-26	2,792	12
3	Eastern Duckran . . .	9-9-24 to 13-9-24	2,568	27-9-25 to 20-10-25	2,209	14

Seed selection. All farm crops are now grown with specially selected seed on the farm and there has been a considerable improvement in the output. A few varieties of *arhar* (*Cajanus indicus*) which are early and admit of easy interculture in



ELEVEN-ROW SEED DRILL SOWING OATS.

cold weather are under trial. Some of the gram selections have proved considerably superior to local varieties.

Out of the imported pasture grasses, Rhodes grass, Natal grass, Para grass, Vassi grass and Kikuyu grass appear promising. They passed through the long dry season quite successfully, and it is proposed to try them on a large scale for pastures.

V. MACHINERY.

The steam ploughing tackle worked during the year for 103 days. The analyses of output, cost and consumption are given in Tables VI and VII.

Tractors. Austin, Fordson and Cletiac tractors, though fairly old, worked steadily for light operations and for belt work.

Trials were made with three ploughs sent by the Agricultural Engineer, Burma, and a bullock cultivator invented by the Agricultural Engineer, Punjab, Lyallpur, and the results were reported upon. A hand rice huller was also tried and a report was issued.

TABLE VI.

Showing cost of working steam tackle for last five years.

Particulars	1921-22 No. of working days 114	1922-23 No. of working days 112	1923-24 No. of working days 120	1924-25 No. of working days 87	1925-26 No. of working days 103
	Rs.	Rs.	Rs.	Rs.	Rs.
Labour	1,243	1,278	1,317	974	1,368
Fuel	1,622	1,464	1,819	1,498	1,781
Oil	412	483	486	410	350
Miscellaneous stores, etc., and renewals	1,783	2,137	611	1,048	3,532
TOTAL .	5,060	5,362	4,233	3,930	7,031

TABLE VII.

Showing the above cost divided into different operations per acre for the last five years.

Particulars	1921-22			1922-23			1923-24			1924-25			1925-26		
	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work
Ploughing	Acres 241.5	Rs. 5.6	Acres 7.8	Acres 373.0	Rs. 5.51	Acres 8.34	Acres 374.0	Rs. 4.99	Acres 7.06	Acres 359.25	Rs. 4.76	Acres 9.5	Acres 393.75	Rs. 8.09	Acres 8.45
Disc harrowing	442.0	2.6	16.5	470.0	2.81	16.50	534.5	2.43	14.46	323.75	3.27	13.8	512.25	3.43	19.93
Grubbing	600.5	2.0	21.3	507.0	2.25	21.00	494.0	1.80	19.55	320.00	2.47	18.3	238.00	2.83	24.16
Rolling	285.0	2.0	21.0	333.5	2.06	23.00	127.5	1.45	24.28	165.50	2.21	20.4	529.50	2.66	25.64
TOTAL	1,569.0	..	..	1,683.5	..	..	1,530.0	..	..	1,168.50	..	..	1,673.50	..	..



A pure young Montgomery cow.



Three-gallon a day half-bred Ayrshire-Montgomery cow Polly No. 18.

VI. MILK PEDIGREE HERD.

The following breeding operations were in progress during the year under report :—

(a) Line breeding with a pure Montgomery herd by selection of sires descended from distinguished dams. The Montgomery herd has attained the present standard of excellence in productive capacity owing to rigid selection and gradual weeding out of inferior milkers. Out of 78 cows at present in the herd, 4 have done over 6,000 lb., 8 over 5,000 lb., and 23 over 4,000 lb. of milk during the lactation period of 300 days. The daily average yield per Montgomery cow has gone over 14 lb. a figure never attained before. The best performances of the year were :—

Serial No.	Name and No. of cow	Total yield of milk during the full period of lactation
		lb.
1	Kamli 312	7,053
2	Tutia 318	5,865
3	Bina 356	5,399
4	Sampati 311	4,619
5	Lotini 327	4,426
6	Rambha 434]	4,569
7	Mina 338	4,414
8	Basmati 452	4,685

(b) Crossing of poor milkers in the pure Montgomery herd with an Ayrshire bull. The average yield of milk per cow per day has gone over 20 lb. in this section of the herd.

Out of the total number of 40 half-bred Ayrshire-Montgomery cows, one has given over 9,000 lb., 2 over 8,000 lb., 5 over 7,000 lb. and 8 over 6,000 lb. of milk in one lactation. It is with regret that I have to record the death during the year of the two best half-bred cows Alibi and Patty who had

given over 10,000 lb. (Appendix III). The best performances of the year were :—

Serial No.	Name and No. of cow	Total yield of milk during the full period of lactation
		lb.
1	Polly 18	9,568
2	Kitty 10	8,478
3	Nelly 13	8,183
4	Bella 23	7,043
5	Nora 42	7,044
6	Glory 22	7,247
7	Aggie 19	6,480
8	Dollie 20	6,430
9	Maudie 40	6,069
10	Lena 81	6,504
11	Tomina 123	6,429

(c) Crossing of half-bred Ayrshire-Montgomery cows with pure Montgomery bulls. Only one cow has come in milk from the progeny of this crossing and is doing well. We have 29 heifers to come in in about two to three years' time, and we shall then be in a position to form a definite opinion about this cross.

The results of crossing cross-bred cows with cross-bred bulls and also with an Ayrshire bull having proved disappointing, this line of work has been discontinued.

Feeding. With the completion of the reclamation of the fodder growing area in the *dhab*, it has become possible to regularize feeding and grazing throughout the year. The

following programme was followed for feeding and grazing green fodder with a view to obtain an almost uniform yield of milk per cow per day, as is shown in Table VIII :—

Month	Feeding in the byre	Grazing in the field
July 1925	Green maize chopped up	Meth and maize
August	Do.	Guar
September	Do.	Cowpeas
October	Silage	Meth
November	Do.	Soybean
December	Silage and berseem	Berseem
January 1926	Berseem	Berseem
February	Do.	Do.
March	Do.	Do.
April	Berseem and silage	Do.
May	Maize and silage .	Meth and maize
June	Maize	Do.

Concentrates and a little dry oat *bhusa* given in addition.

Yield of milk. It will be seen from Table VIII that $4\frac{1}{4}$ lakh pounds of milk were produced this year as against $4\frac{1}{2}$ lakh pounds in the previous year. The average yield per cow per day increased from 14.4 to 15.5 lb. which is over $1\frac{1}{2}$ gallons per cow, a record unprecedented before.

TABLE VIII.
Total milk production during 1925-26.

Month	MILK YIELD IN LB.		AVERAGE YIELD IN LB. PER DAY AND PER COW PER DAY						
	Cross-bred cows	Montgomery cows	Total	CROSS-BRED COWS		MONTGOMERY COWS		TOTAL	
				Average per day	Average per cow per day	Average per day	Average per cow per day	Average per day	Average per cow per day
July 1925	22,726	15,026	37,752	733	17.0	485	13.1	1,218	15.2
August	18,558	15,337	33,895	599	14.9	495	12.8	1,093	13.8
September	17,228	13,350	30,578	574	14.3	445	12.3	1,019	13.4
October	20,813	11,965	32,778	671	16.4	386	11.8	1,057	14.3
November	24,644	11,098	35,742	821	18.2	370	11.9	1,191	15.7
December	27,564	10,832	38,396	889	18.9	349	12.0	1,239	16.3
January 1926	28,325	10,381	38,706	913	20.3	335	11.5	1,249	16.8
February	25,168	9,291	34,459	898	20.1	332	11.4	1,230	16.6
March	24,812	10,549	35,361	800	19.5	340	11.0	1,140	15.8
April	22,936	10,646	33,582	764	19.1	316	12.6	1,080	16.6
May	23,175	11,891	35,066	747	18.6	384	12.8	1,131	16.1
June	22,798	12,743	35,541	760	17.6	424	14.1	1,184	16.2
TOTAL	2,78,747	1,43,109	4,21,856	764	17.9	388	12.3	1,152.6	15.5
TOTAL FOR 1924-25	2,71,809	1,79,152	4,50,961	745	16.8	490	11.1	1,236	14.4

General. The strength of the herd at the end of the year stood at 346 animals. The condition of the cattle throughout the year was exceedingly good owing to the incessant supply of green fodder. They were free from any sort of contagious diseases.

Financial results. The total returns from the sale of cattle, milk and milk products amounted to Rs. 40,632 as against Rs. 29,585 in the preceding year. Eighty-five animals were disposed of from the herd during the year, realizing Rs. 11,216-10. The highest prices obtained were for a pure Montgomery bull Rs. 750, for a half-bred cow Rs. 330, and for a Montgomery cow Rs. 290 (Appendix I).

Percentage of cows in milk. This is a very important problem from the milk producer's point of view who sells fresh milk direct. A constant number of cows in milk throughout the year means a constant supply of milk to the regular customers and a full control over the market. The following statement shows the percentage of cows in milk in the Pusa herd during the year under report.

TABLE IX.

Percentage of cows in milk and dry in Pusa herd during 1925-26.

Month	CROSS-BRED COWS				MONTGOMERY COWS				TOTAL CROSS-BRED AND MONTGOMERY COWS			
	Total No. of cows	In milk	Dry	Per cent. in milk	Total No. of cows	In milk	Dry	Per cent. in milk	Total No. of cows	In milk	Dry	Per cent. in milk
July 1925	64	43	21	67.2	82	37	45	45.1	146	80	66	54.8
August	64	40	24	62.5	82	39	43	47.5	146	79	67	54.1
September	66	40	26	60.0	83	36	47	43.3	149	76	73	51.0
October	67	41	26	61.2	83	33	50	40.0	150	74	76	49.3
November	67	45	22	67.1	88	31	57	35.2	155	76	79	49.0
December	61	47	14	77.0	70	29	41	41.4	131	76	55	58.0
January 1926	60	45	15	75.0	71	29	42	40.8	131	74	57	56.4
February	60	44	16	73.3	67	29	38	43.2	127	73	54	57.4
March]	58	41	17	70.7	71	31	40	43.6	129	72	57	55.8
April	55	40	15	72.7	73	25	48	34.2	128	65	63	50.8
May	54	40	14	74.1	74	30	44	40.5	128	70	58	54.7
June	54	43	11	79.6	78	30	48	38.4	132	73	59	55.3
Average per month	60.8	42.4	18.4	70.0	77	31.6	45.3	40.0	138	74	64	54.0
Average per month during 1924-25	63	44	19	70.0	91	44	47	49.0	154	88	66	57.3

VIII. MISCELLANEOUS.

The farm land outside Pusa Estate known as the New Area and measuring 149 acres was taken over from the Secretary, Sugar Bureau, on 1st April, 1926, along with all agricultural work on sugarcane carried on by him. Budget provision has been sanctioned by the Government for the development of this area. Work in connection with levelling and an irrigation scheme has already been started.

An auction sale of surplus dairy stock was held in December last and was well attended.

Demonstrations on bringing waste land into cultivation and utilizing it profitably for growing fodder were held during the time of the meeting of the last Board of Agriculture, and interested members were shown round the farm.

The old thatched roofs of the cattle sheds were renewed with galvanized corrugated iron sheets and were re-modelled for the production of milk under the most sanitary conditions.

To deal with the surplus milk which could not be sold locally, a Government milk shop was opened at Muzaffarpur town, 22 miles from Pusa, and milk was transported by a motor lorry. The quantity sold at the above depôt amounted to 94,705 $\frac{3}{4}$ lb.

IX. PROGRAMME OF WORK FOR 1926-27.

1. (a) Practical treatment of pedigree dairy herd of Indian cattle and pedigree dairy herd of Montgomery-Ayrshire cattle.

(b) Continuance of experiments with regard to fixing a type of Montgomery-Ayrshire most suitable to Indian conditions.

2. Practical treatment of a 1,200-acre mixed farm with particular attention to profitable modern machinery and the financial results of the work.

The bulk of the produce of the Pusa Farm is used for the maintenance of the dairy herd. The rotation adopted aims at the upkeep of the fertility of the land along with supply of concentrated food and long fodder and a constant supply

of green fodder throughout the year. Included in the above is the study on a practical scale of :—

- (a) Rotations.
- (b) Crops for fodder, seed and silage.
- (c) Implements and machinery.
- (d) Technique of cultural operations.

3. Continuation of collection of data and results regarding the cost and capabilities of the steam-ploughing tackle on estates of this size.

4. Experiments with various types of motor tractors and ploughs for collection of data and working costs and for determination of most suitable types of tractors and implements for India. Also collaboration with manufacturers regarding the manufacturing and introduction of improvements in standard types to suit Indian conditions.

5. *Experimental work at Pusa—*

- (a) Rotational experiments.
- (b) Trial of new varieties of crops, especially leguminous fodder crops.
- (c) Manurial experiments, especially seasonal and quantitative tests with phosphates.
- (d) Trial of sugarcane varieties suitable for growth without irrigation, along with the Sugar Bureau.

6. Demonstrations, exhibitions and sales of surplus dairy stock, etc., will be held from time to time as occasion offers.

7. *Touring and Advisory.* Visits will be paid to provincial agricultural centres.

APPENDIX I.

List of cattle sold during the year 1925-26.

Serial No.	Particulars	Price	REMARKS
	MONTGOMERY COWS (24).	Rs.	
1	Jagti 322	195	The average price fetched by a Montgomery cow is Rs. 128-10.
2	Koselya 362	265	
3	Shanti 329	155	
4	Abilya 331	255	
5	Ganika 345	60	Highest price.
6	Keerty 352	280	
7	Maya 359	220	
8	Sushila 365	125	
9	Nari 381	110	
10	Bimla 382	185	
11	Hathia 386	175	
12	Madhuri 401	175	
13	Boondi 402	290	
14	Mahila 417	245	
15	Rooperi 170	40	With her bull-calf.
16	Mahajani 348	50	
17	Mangli 109	125	
18	Parbati 245	20	
19	Runia 281	31	
20	Chakli 203	5	
21	Kabutri 236	14	
22	Joogni 142	18	
23	Begami 107	12½	
24	Bhawani 214	40	

APPENDIX I—*contd.**List of cattle sold during the year 1925-26—contd.*

Serial No.	Particulars	Price	REMARKS
	HALF-BRED COWS (4).	Rs.	
25	Betty 39	330	Highest price.
26	Calara 63	230	
27	Viola 46	200	
28	Ella 28	300	
	MISCELLANEOUS CROSS COWS (11).		
29	Bee 68	125	The average price for 15 cross bred cows is Rs. 175-8.
30	Bree 121	185	
31	Minnie 84	70	
32	Brune 85	125	
33	Beryl 110	265	
34	Cherry 58	200	
35	Betsy 122	100	
36	Barthel 111	60	
37	Barbara 89	125	
38	Bonny 139	180	
39	Milly 133	140	
	MONTGOMERY BULLS (4).		
40	Arjun 298	400	
41	Abdul Kadir 143	500	
42	Rawan 349	750	Highest price.
43	Chandar 355	300	
	MISCELLANEOUS CROSS BULL.		
44	George 80	200	The average price for 17 bulls is Rs. 254.

APPENDIX I—*contd.**List of cattle sold during the year 1925-26—contd.*

Serial No.	Particulars	Price	REMARKS
	MONTGOMERY BULL CALVES (12).	Rs.	
45	376	200	
46	384	300	Highest price.
47	392	285	
48	401	300	
49	402	230	
50	404	90	
51	405	100	
52	407	95	
53	372	200	
54	406	230	
55	414	145	
	MONTGOMERY HEIFER (1).		
56	413	51	The average price for 12 heifers is Rs. 80.
	MISCELLANEOUS CROSS HEIFERS (11).		
57	156	65	
58	158	75	
59	168	46	
60	137	100	
61	153	60	
62	135	45	
63	154	110	
64	155	80	
65	149	100	
66	142	150	Highest price.
67	140	75	

APPENDIX I—*concl'd.**List of cattle sold during the year 1925-26—concl'd.*

Serial No.	Particulars	Price	REMARKS
	MISCELLANEOUS STEERLINGS (22).	Rs.	
68	121 }	28	
69	123 }		
70	127 }	14	
71	128 }		
72	129 }	16	
73	133 }		
74	130 }	27	
75	132 }		
76	126 }	33	
77	131 }		
78	119 }	27	
79	124 }		
80	122 }	34	
81	125 }		
82	118	5	
83	of Benny.	$\frac{1}{4}$	
84	117 }	25	Joint Director, Pusa, for estate work.
85	120 }		
86-89	113-116	Free	Imperial Agricultu- rist for farm work.
90-107	18 Miscellaneous cross young bull-calves, only few days old.	Free.	
108-109	2 Montgomery cows	Free	Samastipur Pinjra- pole.
	TOTAL .	11,216 $\frac{5}{8}$	

APPENDIX II.

List of cows of the Pusa herd which completed their lactation during 1925-26.

Serial No.	Name and No. of cow	Date of birth	Number of calving	Quantity of milk (lb.) given during the year (days)
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I. SAHIWAL COWS.

1	Kamli 312	7-11-16	5	7,053 (304)
2	Tutia 318	5-2-17	5	5,865 (292)
3	Iina 356	22-6-18	3	5,399 (304)
4	Basmati 452	3-8-22	1	4,685 (304)
5	Samrati 311	31-10-16	4	4,619 (306)
6	Rambha 434	10-6-21	1	4,569 (305)
7	Lotni 327	31-3-17	5	4,426 (304)
8	Mina 338	17-11-17	4	4,414 (306)
9	Mania 388	4-7-19	3	4,286 (306)
10	Milapi 263	11-11-14	5	4,168 (279)
11	Hanun ati 399	10-2-20	3	4,105 (293)
12	Rookmini 332	30-9-17	4	4,057 (304)
13	Reema 447	23-3-22	1	4,005 (304)
14	Mirza 396	27-12-19	2	3,895 (304)
15	Sita 330	30-8-17	4	3,826 (304)
16	Mansi 448	1-4-22	1	3,695 (303)
17	Mirchai 421	20-1-21	2	3,632 (230)
18	Bhagti 369	25-10-18	4	3,242 (273)
19	Dukhni 325	10-3-17	5	3,208 (219)
20	Godavri 315	21-1-17	5	3,122 (221)
21	Gangia 317	27-1-17	4	2,095 (215)

II. POOR MILKING SAHIWAL COWS KEPT FOR CROSSING WITH AYRSHIRE BULL.

1	Mithi 419	7-12-20	2	3,209 (267)
2	Hundi 383	12-5-19	4	3,076 (264)
3	Sarala 385	20-5-19	3	2,854 (293)
4	Veda 375	30-1-19	4	2,672 (272)
5	Hasni 339	8-12-17	3	2,651 (225)
6	Nasoorti 427	8-3-21	2	2,167 (190)
7	Maheru 429	16-3-21	2	1,821 (150)
8	Maheshri 420	13-1-21	2	1,635 (203)

APPENDIX II—*contd.*

List of cows of the Pusa herd which completed their lactation during 1925-26—contd.

Serial No.	Name and No. of cow	Date of birth	Number of calving	Quantity of milk (lb.) given during the year (days)
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II. POOR MILKING SAHIWAL COWS KEPT FOR CROSSING WITH AYRSHIRE BULL—*contd.*

9	Nandni 423	29-1-21	2	1,080 (149)
10	Hirni 302	15-4-16	6	838 (80)
11	Bhagni 340	8-12-17	4	632 (80)
12	Makhari 449	13-4-22	2	179 (50)
13	Mandali 445	26-2-22	2	141 (24)
14	Chintamani 439	16-11-21	2	57 (26)

III. SAHIWAL HEIFERS UNDER TRIAL.

1	Manri 431	25-4-21	1	2,258 (304)
2	Rajbi 450	26-5-22	1	950 (117)
3	Munni 454	2-9-22	1	782 (136)
4	Mewa 446	6-3-22	1	369 (55)
5	Chaki 453	15-8-22	1	242 (53)
6	Bala 458	30-10-22	1	232 (55)
7	Chini 460	3-11-22	1	108 (24)
8	Rudra 455	20-9-22	1	41 (13)
9	Genda 442	18-1-22	1	40 (29)
10	Moorgi 459	2-11-22	1	34 (9)

IV. OLD SAHIWAL COWS.

1	Asharfi 211	28-11-12	6	3,368 (289)
2	Akli 231	19-7-13	7	2,752 (238)
3	Deoki 213	14-12-12	6	2,208 (270)
4	Gopi 219	16-3-13	6	1,942 (238)
5	Kadambari 243	10-1-14	6	1,257 (132)

V. HALF-BRED AYRSHIRE-SAHIWAL COWS.

1	Polly 18	4-1-17	5	9,568 (304)
2	Kitty 10	22-5-16	7	8,478 (304)
3	Nelly 13	27-10-16	6	8,183 (304)
4	Glory 22	14-2-17	5	7,247 (304)
5	Nora 42	8-9-18	4	7,044 (303)
6	Bella 23	3-3-17	6	7,043 (304)
7	Lena 81	2-11-20	2	6,504 (304)
8	Dollie 20	9-1-17	7	6,430 (304)

APPENDIX II—concl'd.

List of cows of the Pusa herd which completed their lactation during 1925-26—concl'd.

Serial No.	Name and No. of cow	Date of birth	Number of calving	Quantity of milk (lb.) given during the year (days)
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V. HALF-BRED AYRSHIRE-SAHIWAL COWS—cont'd.

9	Aggie 19	8-1-17	6	6,358 (304)
10	Maudie 40	16-6-18	4	6,069 (304)
11	Anne 16	20-12-16	6	5,573 (281)
12	Cynthia 35	9-11-17	5	5,517 (284)
13	Fanny 21	11-2-17	6	5,399 (306)
14	May 29	3-8-17	5	5,294 (248)
15	Liza 100	16-8-21	2	5,049 (304)
16	Cora 79	21-8-20	2	5,029 (304)
17	Lettie 97	25-7-21	2	4,941 (304)
18	Jess 59	6-3-19	4	4,832 (255)
19	Hettie 61	11-3-19	3	4,517 (305)
20	Lassie 65	24-11-19	3	4,301 (242)
21	Lottie 91	4-4-21	2	4,020 (255)
22	Esmie 33	27-10-17	5	3,364 (219)
23	Connie 64	22-11-19	4	1,378 (165)
24	Lennie 30	27-8-17	6	1,080 (170)

VI. MISCELLANEOUS CROSS COWS.

1	Ogla 38	16-1-18	3	5,197 (303)
2	Mercy 74	31-3-20	2	4,500 (304)
3	Beaula 70	5-3-20	2	4,497 (304)
4	Flo 32	22-10-17	4	4,369 (280)
5	Bessie 56	5-2-19	3	3,495 (239)
6	Belle 102	29-8-21	1	3,355 (304)
7	Benny 107	29-9-21	1	3,193 (292)
8	Mariah 95	9-7-21	1	2,565 (304)
9	Martha 124	17-6-22	1	2,232 (215)

VII. HALF-BRED AYRSHIRE-SAHIWAL HEIFERS.

1	Tomina 123	16-5-22	1	6,429 (306)
2	Tenny 127	26-9-22	1	5,343 (306)
3	Letitia 125	21-7-22	1	5,059 (305)
4	Lucia 120	4-2-22	1	4,345 (306)
5	Lolla 119	2-1-22	1	4,141 (304)
6	Tilly 112	22-11-21	1	3,757 (303)

APPENDIX III.

Histories of $\frac{1}{2}$ -bred cows Alibi No. 3 and Patty No. 8.

ALIBI No. 3.—Sajni No. 79 (3,921 lb.) and Mossgeil Titanic.

Date of birth—23rd January, 1915.

Date of first calving—22nd October, 1917.

Lactation	lb.
I	7,271
II	7,989
III	9,722
IV	11,839
V	12,018
VI	9,941
VII	10,054
TOTAL	68,834

Died on 6th November, 1925.

Dropped 8 calves—5 cow-calves and 3 bull-calves.

1 heifer died.

1 heifer, $\frac{3}{4}$ bred Flo 32 in milk.

1 heifer, D. C. Martha 124 in milk.

2 young heifers.

1 bull-calf died.

1 bull-calf castrated for general farm work.

1 bull George No. 80, sold at Rs. 200.

PATTY No. 8.—Rangeli 145 (3,333 lb.) and Lessnessock Wild Fire

Date of birth—19th March, 1916.

Date of first calving—16th March, 1919.

Lactation.	lb.
I	5,350
II	3,852
III	8,156
IV	8,425
V	5,673
VI	7,946
VII	10,134
TOTAL	49,536

Died on 20th April, 1926.

Dropped 8 calves—5 cow-calves and 3 bull-calves.

2 cow-calves died at birth.

2 double cross cows (Bee and Bridget) sold.

2 bull-calves castrated.

1 bull-calf sold when young.

1 cow-calf still young.

REPORT OF THE IMPERIAL DAIRY EXPERT.

(WILLIAM SMITH.)

I. INTRODUCTION.

Mr. Zal R. Kothavala, B.Ag., B.Sc., N.D.D., was appointed by the Government of India as Assistant Imperial Dairy Expert and joined at Bangalore on 30th November, 1925. I was in charge of the work up to 28th April when on proceeding on leave I handed over to Mr. Kothavala. The increased interest in the cattle-breeding and dairying industry referred to in the introductory paragraph of my last year's report still maintains its hold on the agricultural interests of the country so much so, that at the Board of Agriculture meetings at Pusa, in December, the discussions mostly centred around subjects connected with cattle-breeding and dairying. The country is slowly awakening to the realization of the fact that this cattle-milk problem is the most universal and most important of all agricultural problems, and that any scheme for the development of Indian agriculture which does not include the improvement of the Indian milch cow and the working ox can have no great effect in advancing the economic condition of the peasant. The efficiency of the cultivation of every crop and the health and physique of the cultivator and his family, depend upon the cattle problem, and sooner or, later it must be recognized that the dairying industry in India is more important than the cotton industry or the jute industry or the sugar industry, because the improvement of the dairy industry means the development of the cow and the cow is essential to produce the bullock and without the bullock India would be helpless agriculturally. The demands made upon this office throughout the year for technical advice on dairying and cattle-breeding matters from all parts of the country continue to increase, and at the moment practically every Provincial Government in the country and many of the larger States

are considering some form of scheme for the bettering of their cattle and the development of their dairy interests. Alas, that so many of these schemes take such long years for consideration and in many cases never get beyond the consideration stage at all.

The outstanding feature of the year in the direction of dairy progress is the bold step taken by the Co-operative Societies Milk Union in Calcutta, in erecting and equipping with the most modern and up-to-date machinery what is undoubtedly the first model city milk plant in India, and in this connection special praise is due to the Corporation of the City of Calcutta for the support and encouragement given to the Union in the shape of financial assistance free of interest. The action of this municipality in taking real practical steps to improve the milk supply of their city through the medium of the co-operative movement might well be copied by many city municipalities and urban authorities in India.

Recognizing that the cattle-breeding problem in India can never be placed on an economic basis without the development of technical dairying, I have, since taking over this appointment, pleaded for the establishment of an experimental and educational dairy factory in India, where the manufacture of milk products could be studied on a factory scale and where the treatment of milk for the manufacture of milk factory products could be taught on practical lines. In response to this demand the Government of India in October 1925 authorized this department to take over the disused military creamery at Anand in Gujarat as a temporary measure. To commence with, Government have stipulated that this creamery shall be self-supporting, and this condition, of course, debars the factory from carrying out research work of any kind for the present. India imports enormous quantities of condensed milk, dried milk, malted milk and milk foods of various kinds, most of which could be made in the country, and the need of investigation into the manufacture of these products is urgent. It will not be enough for the Agricultural Departments of this country to provide the cultivator with an efficient milking cow. There must, along with the heavy

milking cow, be provided a means of selling the produce of the cow, and for this reason alone, it is vastly important that this question of research into the manufacture of milk products should be undertaken without delay. Then, in addition to the question of the manufacture of milk products we now import, there is the question of the study of methods of manufacture, transport, and storage of the dairy products, such as *ghi*, butter and curd, which are now made and consumed in India in enormous quantities and the quality of which is anything but what it ought to be, due largely to want of technical knowledge of methods of manufacture and handling.

The Government of India have decided that I should, in addition to my existing duties, act as Secretary of the Cattle Bureau to be formed on the recommendation of the 1924 (Bangalore) meeting of the Board of Agriculture. The question of the working of this Bureau was considered at the meeting of the Board of Agriculture at Pusa in December 1925, and the Board unanimously recommended that the control of this Bureau be vested in an expert executive committee nominated by the various Provincial Governments, the larger Indian States, and the cattle-breeding interests. In view of this recommendation and awaiting its acceptance or otherwise by the Government of India, no great progress has been made in commencing the work of this much needed central authority. Should the Government of India agree to the Board's recommendation, this office will at once call a meeting of the executive committee and proceed to carry out the duties under the committee's direction for which the Bureau has been formed. Meantime a commencement has been made in the work of the Bureau in the compilation of lists of all available pedigree cattle in the country which are for sale and the circulation of these lists to all likely buyers. Steps are also being taken to form registers of all Sahiwal and Scindi cattle suitable for registration for herd record purposes, so that the Bureau may be able to submit concrete proposals for its working to the executive committee, if, and when, it is formed.

II. TRAINING.

The first lot of students studying for the Indian Dairy Diploma finished their term in December, and twelve of these sat for examination; of these twelve, nine passed, two with honours.* The three students taking the first three places in this examination were given gold, silver, and bronze medals, very kindly donated by the Indian General Trading Co., Ltd., of Bombay. In addition to the beforementioned, fifteen students presented themselves for examination for this diploma at the Allahabad Agricultural Institute, Allahabad, and of these, seven passed.† Attached as an appendix (I) of this report are the examination papers set to the students both at Bangalore and Allahabad.

A new class for the Indian Dairy Diploma was commenced at the Bangalore farm in January 1926 for which 23 students have been enrolled. In connection with this class some 500 enquiries for information were received from all over India and Burma, and the 23 students now enrolled were selected from 69 actual applications received. The new students include men from almost every caste and community in the country and have been drawn from the following provinces: Bombay, Madras, United Provinces, Bihar and Orissa, Bengal, Assam, Delhi, Baroda State, Mysore State, Gwalior State, Cochin State, and Travancore State.

Sixteen short-course students from Burma, Ceylon, Punjab, Bombay, Baroda State, Bengal and Delhi, and 24 veterinary assistants deputed by the Punjab Government received technical instruction during the year at the Bangalore and Karnal farms.

In September last, a special class consisting of 22 officers of the Co-operative Departments of the Punjab, Bengal, Bombay, United Provinces, Baroda and Cochin States was enrolled at Bangalore for a three months course in co-operative dairying.

* (In order of merit) D. N. Khurody (Hons.), V. Wazir (Hons.), M. C. Rangaswamy Iyengar, H. C. Verma, G. G. Oka, F. J. Morenas, M. V. Krishnaswamy Iyer, S. G. Nadkar, and K. K. Desai.

† (In order of merit) P. N. Sud, B. N. Saksena, M. C. Dutt, N. R. Joshi, D. H. Anjaria, J. P. Nagarseth and H. P. Saksena.

This course was completed at the Karnal farm, and the officers who attended the course evinced a very special interest in the subject taught. It is my opinion that India offers a great and promising field for the development of co-operative dairying, and it is certain that the education of experienced co-operative officers of the class who attended this course must do much to assist the development of the dairy-cattle breeding industry in the country.*

Two post-graduate students completed their course of training at farms under my charge during the year, and one post-graduate student joined for training on 5th February, 1926.

Mr. F. J. Warth, Physiological Chemist to Government, and his staff again played an important part in the training of the students, both post-graduate and diploma, and in addition to this work Mr. Warth very kindly undertook the examination and reporting on feeding stuffs from all the farms under my control. I greatly appreciate Mr. Warth's ready help and co-operation in all that pertains to the welfare of the farms and the advancement of the dairy industry.

In accordance with the practice followed in previous reports, the advisory work done may be classed as:—

- (a) Work done for Local Governments, Indian States
Municipalities, etc.
- (b) Advice given to the general public in India.
- (c) Information given to persons or Governments outside
India.

II. WORK DONE FOR LOCAL GOVERNMENTS, INDIAN STATES, AND MUNICIPALITIES.

Bombay. I visited Bombay on 21st August, 1925, and there discussed with the Dairy Superintendent of the Bombay Municipality the legal deadlock in connection with the proposed subsidized milk companies in the vicinity of Bombay, and in view of the position from a legal point I declined to inspect

* This course has since been discontinued under the orders of the Government of India [Z. R. K.].

the proposed lands. The Bombay Corporation were given the loan of a dairy cinema film, and my assistant Mr. Kothavala advised and rendered the Health Officer of Bombay help in organizing a milk exhibit in connection with their National Baby Week of 1925.

I visited Poona on 15th March, 1926, and advised the Live Stock Expert to the Government of Bombay and the Professor of Agriculture, Poona, regarding dairy exhibits for the Agricultural Show to be held at Poona in October 1926.

Baroda State. The Director of Industries, Baroda State, interviewed the writer in Bombay in July 1925, and discussed certain matters regarding the working of the Palace Dairy and Cattle Breeding Farm, and as a result of this conference I furnished him with detailed recommendations in writing for the working of the farm. This officer was also given loan of a set of account forms in use at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and certain books on dairying from the library of this office. The Superintendent of the Palace Dairy and Cattle Breeding Farm, Baroda, was advised in dairying and cattle-breeding matters from time to time.

Bengal. The Director of Agriculture was in correspondence with this office during the period under report on cattle-breeding and dairying matters.

At the request of the Deputy Chairman, Calcutta Co-operative Milk Societies Union, revised plans for proposed dairy buildings at Sealdah, a note regarding materials to be used in the construction of the building, and revised machinery specifications were provided. I visited Calcutta on 5th August, 1925, in order to advise the officials of the Union concerning suitable plant for their milk depot, and on 20th August I selected, branded and shipped three Scindi bulls at Karachi for this organization. I again visited Calcutta on my way to Pusa on 2nd December, and after examining various site selected a site in the city of Calcutta for the erection of the new milk pasteurizing depot for the Union. At my recommendation, Mr. H. C. Verma, who passed the Indian Dairy Diploma examination in January 1926, was appointed Assis-

tant Manager of the beforementioned milk depot, and the services of two skilled dairy boys were secured for this concern.

The Executive Engineer, Second Calcutta Division, was supplied with detailed information regarding the construction of cattle sheds, and was also advised as to the best method of disposing of manure.

An article on the improvement of cattle in India, and a scheme for the distribution of breeding bulls received from the All-India Cow Conference Association, Calcutta, was criticised. Later on two articles written by a member of this association on cattle-breeding (published in the journal "Welfare" for June and July 1925) were also criticised at the request of the Secretary.

Madras. The Deputy Director of Agriculture, Live Stock, Madras, was in correspondence with this office throughout the period under reports on cattle-breeding and dairying matters, and at his request I provided him with a detailed scheme with dairy plans and machinery specifications, etc., for the establishment of a dairy farm at Hosur. I visited Madras on 3rd August to discuss with the Director of Agriculture, Madras, the before mentioned scheme for the development of the Hosur Cattle Farm, and to see the conditions of the milk supply by the Bangalore Dairy Institute to the Madras hospitals. Later on the services of a trained European Dairy Manager with Indian experience were obtained for the Hosur farm.

At the request of the Zamindar of Kangundi, I visited his estate on 10th September to select the foundation stock for his proposed cattle-breeding farm, and as a result of this visit plans and machinery specifications were furnished for a farm at Kangundi, and the Zamindar was advised generally as to the development of cattle breeding and dairying in the track of some 400 square miles of land belonging to him. Later on I selected two Scindi bulls at Karachi for this Zamindar.

At the request of the Deputy Director of Agriculture, Live Stock, Madras, a revised scheme on a small scale with plans and machinery specification for the Ootacamund Municipi-

pality was supplied. Later on the Chairman of the Municipal Council, Ooty, was supplied with a note of probable cost of $\frac{3}{4}$ -cross-bred milch cows, the average number of cows of this breed which would remain in milk throughout the year, and their approximate milk yield. Early in April 1926 I visited Ootacamund and advised the Chairman regarding the establishment of the proposed municipal dairy and quoted him for the supply of cross-bred cattle from the Bangalore farm.

Punjab. The Director of Agriculture, Punjab, was in correspondence with this office throughout the period under report on cattle-breeding and dairying matters. On 10th August I visited Simla to advise him regarding the proposed new cattle farm in that province and the establishment of a milk condensing factory. In company with the Hon'ble Minister for Agriculture, the Registrar of Co-operative Societies, and the Director of Agriculture, Punjab, I visited Shergarh on 11th November, and inspected the cattle of the various grantees in that district, selected sites for two dairies, explained to the Director of Agriculture the best method to be adopted in organizing the land grantees for co-operative milk production, and supplied him with a complete set of plans for cattle sheds, dairy buildings, godowns, and servants' quarters for Syed Mohamed Hussain, M.L.C., Shergarh. At the same time, I advised the Registrar of Co-operative Societies regarding the inauguration of co-operative milk societies in the Shergarh District.

I visited the Hissar cattle farm on 28th January, 1926, to arrange for the recording of milk yields of selected cows for this farm at Karnal.

At the request of the Director of Agriculture, I visited Lahore on 4th February for valuing the dairy machinery of Mrs. Brown's dairy, and also submitted a report to the Financial Commissioner, Punjab, on the working of this farm.

Nabha State. At the request of the State Engineer, Nabha, I selected and branded on 10th February at Karachi 12 Scindi cows and one bull for the State dairy, and the services of a qualified dairy manager were secured for them. Later on I deputed Mr. Gossip, Superintendent, Karnal Farm, to visit

Nabha to advise the State authorities on cattle-breeding and dairying matters.

Delhi. In company with the Superintendent, Karnal Farm, I visited Delhi on 19th August, 1925, in order to examine a number of shops as to their suitability for the proposed milk depôt for Raisina.

United Provinces. The Deputy Director of Agriculture in-charge Cattle-breeding Operations, Muttra, was advised from time to time on dairying matters, and was supplied with copies of certain dairy plans prepared by this office and supplied to different parties.

The Officer in-charge of the Dairy Section of the Allahabad Agricultural Institute was in correspondence with this office throughout the period under report in connection with the teaching of the dairy diploma class under training at the institute.

Dholpur State. The Private Secretary to His Highness the Maharaja of Dholpur was advised as to the best type of men suitable to run their dairy farm, and at the request of the State authorities I visited Dholpur, in company with the Agricultural Adviser to the Government of India, on 19th January and examined the existing State dairy farm there. As a result of this visit, particulars were furnished for the modernization of the same with building plans and a note on estimated cost of suggested improvements, and a list of establishment necessary to run the dairy farm on modern lines.

Bihar and Orissa. The Director of the Civil Veterinary Department, Bihar and Orissa, was in correspondence with this office throughout the period under report on cattle-breeding matters, and a note on cost of rearing calves and the average number of bull calves available at the Bangalore Dairy Institute for distribution was supplied to this officer. I visited Patna on 13th December, and at the request of the Hon'ble Minister for Agriculture of that province attended a conference between the Director of the Civil Veterinary Department and the two Indian Ministers of the Government of Bihar and Orissa,

relative to the establishment of a cattle-breeding farm in that province. At the request of the Director I again visited Patna on 23rd February when I inspected the site for the proposed dairy farm, and delivered a lecture, illustrated with dairy cinema films, at a public meeting on the importance of cattle-breeding and dairying in India. His Excellency Sir Henry Wheeler, the Governor of this province, presided at this meeting which was also attended by many members of the Legislative Council of Bihar and Orissa.

The Tata Iron and Steel Co., Jamshedpur, were supplied from time to time with information on dairying and cattle-breeding matters, and at my recommendation they appointed Mr. Khurody, who stood first in the Dairy Diploma examination held at Bangalore in December 1925, as their Farm Manager. On 10th March, I selected for this company at Karachi 8 Scindi cows. In April Mr. Kothavala visited Jamshedpur and discussed the general question of the milk supply of the town with the authorities. Later on a detailed report on this subject with recommendations drawn up by Mr. Kothavala was submitted to the Steel Company.

Burma. The Director of Agriculture, Burma, was advised as to the best manner in which they could utilize godowns for housing dairy cattle of their Agricultural College Dairy Farm, and a plan showing the necessary alterations was provided.

At the request of the Burma Government, I visited Rangoon on 12th February, in order to examine the dairy scheme of the Rangoon Co-operative Dairy Society, Ltd., and submitted to that Government a report on the working of the society with recommendations.

IV. ADVICE GIVEN TO THE GENERAL PUBLIC.

The Secretary of the Calcutta Pinjrapole Society was advised regarding the working of their concern on more economic lines, and at my recommendation Mr. G. G. Oka, G.B.V.C., I.D.D., who passed the examination for Dairy Diploma in December last, was appointed Dairy Farm Manager at a salary of Rs. 250 per month.

Messrs. A. and M. Wazir Ali & Co., Army Contractors, were advised as to the terms for the acquisition of land for their proposed milk products factory.

Mr. B. V. N. Satyanarayana, B.A., Vekil, Royapet (Madras), was supplied with a scheme for working a small dairy of 60 Scindi cows.

In addition to the foregoing, specific advice and information on dairying and cattle-breeding matters was supplied to firms, public bodies and private individuals at Delhi, Calcutta, Bombay, Palwal, Pudukkottai, Palayakattai, Katuputur, Sonrighaon (Assam), Agra, Balasore, Shillong, Tripura State, Bellary, Rawalpindi, Shahpura Chiefship, Bhavnagar, Hardwar, Chittur-Cochin, Booksagra Estate, Quetta, Birsinhapur (Bihar), Bassein, Kodaikanal and Trichinopoly.

V. INFORMATION GIVEN TO PERSONS OR GOVERNMENTS OUTSIDE OF INDIA.

The Director of Agriculture, Ceylon, was advised as to the best breed of cattle suitable for Ceylon, and was supplied with a copy of the plan of the new byre at the Imperial Dairy Institute, Bangalore, as well as a tracing of a plan of dairy buildings suitable for Indian climate.

Mr. W. H. Hagley, Manager, Government Farms, Bue-Cameroons, was advised as to the best zebu cattle suitable for importation to the Cameroons, and was supplied with a copy of the article on Scindi cows written for publication in the „Agricultural Journal for India.”

The Rowett Research Institute, Bucksburn, Aberdeen, were advised about the results obtained at the Imperial Dairy Institute, Wellington, from the feeding of lime and bone-meal to young animals along with rations.

A questionnaire received from the International Institute of Agriculture, Rome, on the subject of dairy cow testing was replied to.

Mr. G. Fitzgerald of Newcastle, Natal, was advised as to the best breed of Indian buffalo-cow suitable for importation to Natal.

Dr. Leake, Principal, Imperial College of Tropical Agriculture, Trinidad, was advised as to the best breed of Indian buffalo suitable for importation to Trinidad, and was also supplied with a note on the cost of importing a Murra buffalo-cow.

An enquiry from the New Zealand Co-operative Dairy Co., Ltd., Hamilton, regarding the possibility of their importing dairy products into India was dealt with.

VI. GENERAL.

Articles on Scindi and Ongole breeds of cattle were written during the period under report for publication in "The Agricultural Journal of India."

A paper on co-operative dairying in India was read at the Science Congress held in Bombay in January 1926.

A cinematograph entertainment illustrative of dairying and cattle-breeding in other countries as compared with India and descriptive of the work of the Imperial Institute of Animal Husbandry and Dairying was given at the Electric Theatre, Bangalore, on 18th September, 1925. The Hon'ble the Resident in Mysore presided at this meeting which was attended by the General Officer Commanding the Bangalore Area and most of the prominent residents of Bangalore and district.

In company with the Agricultural Adviser to the Government of India I visited Agra on 18th January and inspected the Holstein cross-bred cattle of the military dairy farm at that station.

During the week of the meetings of the Board of Agriculture I delivered a lecture to the Pusa Scientific Association illustrated with a cinema film on the importance of cattle-breeding and dairying in India.

VII. KARNAL, BANGALORE AND WELLINGTON FARMS AND ANAND CREAMERY.

Karnal. The policy of developing the Thar-Parkar and Hariana herds at this farm has been continued, and during the year 16 Thar-Parkar cows were purchased in [Sind and 8 Hariana cows and 16 Hariana heifers were purchased from the Hissar

cattle farm of the Punjab Government. The establishment of a small herd of Murra buffaloes has also been taken in hand, and breeding by selection will be practised in all three herds.

Two outbreaks of foot-and-mouth disease occurred in the Karnal herds during the year under review, one of a very severe and the other of lighter type, but outside of these epizootic outbreaks the health of the cattle has been good. The total number of bovine stock of all ages now on the farm is 353.

The year was a good one from the point of view of crop production, both the rice and wheat crops being record ones for the farm. Experiments were made in the growing of potatoes, onions and melons on a field scale with well irrigation. The results are hopeful and efforts are being made to increase the profit earning powers of the farm in this direction. In January the farm was visited by Mr. G. S. Henderson, Imperial Agriculturist, who inspected the farm, investigated the system of cultivation and farming practised, and reported on the working of the farm. The whole of the buildings, plant and machinery on the farm were kept in thorough repair throughout the year. The old farm office now used as an officers' rest room collapsed in the rains, but it has been reroofed and put into thorough repair. The Government of India sanctioned during the year an expenditure of Rs. 7,500 on the remodelling of one of the old farm buildings to make it serve as a students' hostel. This work has now been completed and the farm possesses a comfortably furnished students' hostel with a lecture room, a dining room and cook houses, capable of accommodating some 24 students.

The sterilizing plant has worked without a hitch throughout the year, and in so far as keeping quality is concerned, the farm has had no further trouble with this product.*

* Milk sterilized at Karnal which was keeping in good condition till the time Mr. Smith left, suddenly started going bad owing to excessive heat experienced during the months of May and June. Investigations showed that owing to abnormal heat the metal of the milk cans and the lead rings with which the lids are fixed on the cans expanded and contracted at an uneven rate. This produced air leaks through the lids, which caused the milk to go bad. Further investigations are being carried on to overcome this difficulty. Such trouble was experienced even last year during the hot weather. [Z. R. K.].

The outbreak of foot-and-mouth disease in March interrupted the customary inoculation by the officers of the Imperial Institute of Veterinary Research, Muktesar, for prevention of rinderpest, and it is not intended to attempt the completion of this work until next cold weather.

The co-operative short course students and quite a number of short course students desiring special instruction in cattle management, milk sterilizing, etc., underwent training at Karnal during the year. Mr. F. J. Gossip was in charge of the farm throughout the year, and Mr. S. Cox acted as Assistant Superintendent from November. Both officers did valuable work not only in the executive control of the farm but in the instruction of students both theoretically and practically.

The following appendices (II-VII) are attached :—

- (1) Receipt and expenditure statements.
- (2) Statement of outturn of grain, fodder, etc.
- (3) Produce statement.
- (4) Disposal of produce.
- (5) Herd statistics.
- (6) Statement showing yield of all cows which completed their lactation period during the year.

Bangalore. This farm has been more unfortunate than ever in the year under review. As indicated in my last report, the herd was found to be affected with Johne's disease. In September last the Director of the Imperial Institute of Veterinary Research recommended that animals which had not reacted to the test for Johne's disease should be vaccinated to give them immunity from this disease. As the veterinary authorities gave an assurance that this vaccination would not injure the health of the cattle nor interfere with their yield of milk, I gladly assented to the animals being vaccinated. In all 101 animals were vaccinated, and of these 42 have since died as the result of this vaccination and many of the survivors which were vaccinated show signs of wasting and bad health, so much so that the Agricultural Adviser in valuing these cattle which are mostly young at the annual farm live stock valuation reduced their value by Rs. 4,400. The book value of

animals which have actually died as the result of this vaccination is Rs. 7,755, and the actual loss to the farm in the year under review owing to this vaccination is well over Rs. 20,500.

The removal of the British Cavalry regiment from Bangalore and the despatch of a portion of the British Infantry regiment to Belgaum has materially reduced the demand for the products of the dairy during the year. Attempts were made to secure the contract for the supply of a local civil hospital but were unsuccessful, the competition with the local *gowallas* being very keen.

With the approval of the Agricultural Adviser to the Government the cross-breeding policy lately followed by the farm has been modified and all cows having European blood are now sired by Indian bulls. A specially well bred Sahiwal bull for this type of breeding was obtained from the Pusa farm during the year..

The whole of the buildings and machinery at the farm were kept in thorough order and repair, and the fullest use was made of the farm as a training centre for diploma, post-graduate and short-course students.

The following appendices (VIII-XIII) are attached :—

- (1) Receipt and expenditure statements.
- (2) Statement of outturn of grain, fodder, etc.
- (3) Produce statement.
- (4) Disposal of produce.
- (5) Herd statistics.
- (6) Statement showing yield of all cows which completed their lactation period during the year.

Wellington. The year under review witnessed a considerable improvement in the health of the herd in so far as contagious abortion is concerned, the system of vaccination advocated by the Director of the Imperial Institute of Veterinary Research having given good results. The breeding policy of the military dairy farms has been changed and all cows with European blood are now served by Indian bulls; for this purpose a first class Sahiwal bull was procured from Pusa and two Scindi bulls have been supplied from the

Bangalore pure bred Scindi herd. During the year four animals of the book value of Rs. 950 died from Johne's disease or suspected Johne's disease, but the farm is gradually selling off its $\frac{3}{4}$ and $\frac{7}{8}$ European stock and substituting Indian cows of the Scindi breed which possess a greater degree of natural resistance to diseases of this nature. The most valuable Ayrshire bull in the herd contracted a bad abscess in the genitals which, although treated by the local veterinary officer of the Madras Veterinary Department, has rendered the bull useless for breeding purposes and thereby imposed a loss of some Rs. 2,600 to the farm.

Special efforts have been made throughout the year to improve the cultivation on the farm and to provide a larger quantity of home grown fodder with some considerable degree of success. Intensive cultivation with heavy manuring is being practised, and it is hoped ere long to grow the whole of the fodder requirements of the farm on the dairy lands.

All the demands of the Army Department at Wellington and Coonoor were met during the year. Mr. A. Lamb was in charge up to 1st October and Mr. E. G. Whittick was appointed manager on that date; both officers have done good work on this farm during the year. Owing to the repeated failure of the Nilgiri Hill Railway during the year it was impossible for the Wellington farm to depend upon supplies of milk from Bangalore in the busy season, and in order to provide a supply of milk which could economically be turned into butter in the slack season, eight heavy milking Murra buffaloes purchased in Sind were sent to Wellington farm and the supply of butter to this farm has been undertaken by the Anand Creamery since 1st April, the butter supply from contractor's cream being discontinued. The hill transport of dairy produce feeding stuffs, etc., having been found very heavy on ponies and bullocks, a motor lorry has been substituted for the existing pony and bullock carts; this, it is hoped, will give more prompt delivery and at the same time slightly increase transport costs.

The following appendices (XIV—XIX) are attached :—

- (1) Receipt and expenditure statements.

- (2) Statement of outturn of grain, fodder, etc.
- (3) Produce statement.
- (4) Disposal of produce.
- (5) Herd statistics.
- (6) Statement showing yield of all cows which completed their lactation period during the year.

Anand Creamery. Sanction was obtained to the taking over of this creamery in October, but it was found that there was not a drop of water in the well and the machinery required thorough overhaul and cleaning before it could be worked. The cleaning out and rebuilding of the well took considerable time, and it was 5th December before the creamery commenced operations. The flush season of the year when milk is cheap and plentiful in a good monsoon in the Anand District lasts from August to the beginning of December, so that the factory started too late to get the benefit of this. During the period from the starting of the creamery to 30th June the creamery actually manufactured 44,070 lb. butter and 95 lb. *ghi* and pasteurised and sold 940 lb. new milk and 1,69,720 lb. separated milk. It was found to be very difficult at the commencement to find a market for the butter made. There is a gradual improvement in the demand, but the sales are not yet sufficient to provide a gross profit equal to the working expenses. Since the commencement, the plant has worked well and the water supply in the well has been adequate. A new loco type multitubular boiler was installed when the creamery was taken over, and all the plant, buildings, etc., have been repaired and are being kept in sound working order.

The trading returns of the creamery from the date of taking over until the end of the financial year naturally show a considerable loss, but this figure includes all the preliminary expenses on starting the organization and on getting a footing for our products in the local market.

The following appendices (XX—XXII) respecting the working of the creamery are attached :—

- (1) Receipt and expenditure statement.
- (2) Statements of outturn and disposal of produce.

II.

(ZAL R. KOTHAVALA, B.AG., B.Sc., N.D.D.)

I took over charge of the duties of Imperial Dairy Expert from Mr. Smith who proceeded on leave on the afternoon of 28th April, 1926.

Since taking over charge the following advisory work was performed in addition to the administration of the Section :—

- (a) The Director of Agriculture and Fisheries, Travancore State, was advised as to the cattle-breeding policy he should adopt for his State.
- (b) The Deputy Director of Commerce and Industries, Kashmir State, was advised as to the best breed of buffalo and cow suitable for dairying in that State, and the probable cost at which they could be purchased in the open market.
- (c) The Development Officer, Pudukkottai State, was advised as to the arrangements to be made for the service of the farm bull being made available to cultivators and the fee to be charged for the purpose.
- (d) The Deputy Commissioner of Campbellpur was supplied with information on cultivation of sun-flower as a dairy fodder and converting same into silage for feeding cattle in the dry season.
- (e) Mr. P. S. Caprihan, Simla, was supplied with a scheme with detailed specifications of a dairy plant for the purpose of starting a small dairy.
- (f) The Director of Agriculture, Bengal, was supplied with a note on the conversion of arable land into pasture. He was also advised as to the system of recording history of individual cows on the Rangpur farm and a sample tablet for the purpose was provided.
- (g) At the request of the Director of Commerce and Industries, Baroda State, I visited Baroda on 3rd June, 1926, and submitted a report, after inspec-

tion, on the dairy plant lately erected in the Palace Dairy. The pedigree Gir herd maintained by the State was also inspected by me and advice given as to the general policy to be followed in the breeding of these animals. While at Baroda I selected a site for the proposed dairy farm to be run by the Baroda Pinjrapole Society.

- (h) In addition to the foregoing specific advice, information on dairying and cattle-breeding matters was supplied to firms and private individuals at Chupraon (Bihar), Murshidabad, Dinapore-Khagoul, Calcutta, Jahan-Khelan (Hoshiarpur), Tomokso (Burma), Bareilly, Loralai, Bhusawal, Campbellpur, Bombay, Akyab (Burma), Simla, and Mowlai (Assam).

APPENDIX I.

Report of the first examination conducted at the Agricultural Institute, Allahabad, and the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the Indian Dairy Diploma.

The examination, both theoretical and practical, commenced at the Allahabad centre from 14th December and lasted till 19th December, 1925. At the Bangalore centre the theoretical examination was conducted from 15th to 17th December, and the practical examination from 4th to 7th January, 1926.

In theory six question papers (copies attached) were set, the syllabus of subjects being grouped into suitable subjects as shown below. Hundred marks were assigned for each paper, making an aggregate of 600 marks for the six papers. Fifty per cent. secured on an aggregate a pass and 75 per cent honours.

The following shows the grouping of the syllabus :—

PAPER I.—*Section I*—Principles of breeding and stock judging. *Section II*—Dairy cattle and diseases of dairy cattle.

PAPER II.—*Section I*—Dairy farm management. *Section II*—Milk production, handling, etc.

PAPER III.—*Section I*—Dairy buildings. *Section II*—Dairy and farm engineering.

PAPER IV.—Examination in cheese, butter and *ghi* manufacture and utilization of dairy products.

PAPER V.—*Section I*—Feeds and feeding. *Section II*—Dairy chemistry and dairy bacteriology.

PAPER VI.—*Section I*—Principles of co-operative dairying. *Section II*.—Dairy book-keeping.

3. In the practical, each student was asked to milk a cow and make cheese and butter ; and in order to make the test as thorough as possible, a general practical examination was taken in the identification of fodders, rations, judging of animals, etc. This was followed up by an oral examination in which questions pertaining to the dairy buildings and machinery, soil, crops, etc., were put. Hundred marks were allocated for each of these tests, forming an aggregate of 400 marks and the candidates were required to secure 50 per cent. in each *individual test* in order to pass and 75 per cent. for passing with honours.

4. A special feature of the examination was that the students had to appear for the examination in theory without their being previously informed of the order of subjects.

5. Of the fifteen students who appeared for the examination at the Allahabad centre, seven passed, but none with honours. The answer papers in theory showed that the students had been given too much theoretical science not exactly pertaining to the technique of dairying. The teaching given appeared to be on the lines given in other agricultural institutes in this country where scientific theory is taught with the ultimate object of high academical qualifications. Nothing has alienated the sympathy of the public from the dairy industry in this country in the past more than the failures which have resulted in entrusting dairy enterprises to men who know too much science and very little of practice. If it is intended that the men passing out with the Indian Dairy Diploma should bear the hall-mark of thorough practical training, the tuition given at the Allahabad Institute needs modification.

6. In the practical examination at Allahabad, the standard displayed was very poor on the whole, and it could not be otherwise, looking to the inadequacy of training facilities. No amount of enthusiasm on the part of the staff for teaching and on the part of the student for learning could compensate for this drawback. Not only was the equipment inadequate but it was badly kept. Whatever the appliances are, if they had been more carefully maintained the result in the practical examination would have been better. I am, therefore, of opinion that before this Institute could be expected to impart thorough practical knowledge it must be equipped with the necessary complement of dairy plant and machinery to make it more up-to-date as a teaching centre.

7. At the Bangalore centre, of the twelve students who appeared for the examination, nine passed, out of whom two passed with honours. In theory, the students showed a fairly good grasp of the subject and their practical was quite satisfactory. On the whole, the students who passed out at this centre can be considered to possess the requisite standard required of thoroughly trained dairy managers.

8. If, however, it is desired, and, in my opinion, it is necessary, that the Indian Dairy Diploma should have the same status as the N.D.D. of Great Britain, or for the matter of that any of the other dairy diplomas in Europe, and if the students who pass out are to look forward to becoming really competent dairy managers, it is necessary that the course of training dealing with the technique of dairying should be much more amplified so as to enable the student to take a more intelligent view of what is being done by him in practice. As a first step towards this, it is

necessary to draw up a detailed syllabus indicating the line of teaching to be followed and the limitation to be put to it. This will bring about a greater co-ordination in the training given at the two centres. With this end in view I am submitting a copy of detailed synopsis of the course for the Indian Dairy Diploma which, in my opinion, it is necessary to follow. It is based on the same lines as the training given for N. D. D. in Great Britain, but is modified in such essentials as would suit Indian conditions and according to the requirements of an Indian student.

9. In connection with the examination, I would like to suggest that joint examiners should be appointed, one from the staff called the "home examiner" and the other an "outsider." The former will guide the latter who will principally act as judge of the merits of the candidates. This system of joint examinership prevails everywhere and its necessity is very obvious in this case too.

10. In closing this report I must record my appreciation of the willing co-operation I met with from the staff at both the centres and the zeal they evinced in providing the required facilities both for the examiner and the examinees.

(Sd.) ZAL R. KOTHAVALA,

Examiner.

PAPER I.

N.B.—(1) Answer only *four* questions of each section.

(2) Questions marked with * are compulsory.

(3) Each section to be answered on a separate paper.

Section A—Principles of breeding and stock judging.

1.* In selecting a stud bull of any Indian breed of cattle, what features in the pedigree and history of the animal would you pay most attention to and why ?

2. What is meant by “in-breeding” and “line breeding” ? Why are such systems practised and what are the advantages and disadvantages of each of these systems ?

3. What is your opinion of the usefulness of Mendel’s law as an aid to the practical cattle breeder at the present moment ? Give reasons for your answers.

4.* You are sent to a fair or market to purchase a non-pedigreed bull to be used for breeding dual purpose cattle (draught and milk) in a herd of Indian cows of mixed lineage. Describe how you would proceed to make your selection.

5. What are the points of an ideal draught bullock ?

Section B—Dairy cattle and diseases of dairy cattle.

6. Describe the physical characteristics and dairy qualities of the following breeds of Indian and foreign dairy cows :—Sahiwal, Hariana, Ayrshire, Shorthorn.

7.* What is the present price of a first class young Murra buffalo in full milk in Northern India ? How much milk per annum should such an animal give, and what percentage of fat would this milk contain, what is her body weight in lb. and how often should she bear a calf under normal conditions ?

8. How would you rear a young Scindi or Sahiwal female calf out of a good cow by a pedigreed milking sire from birth to one year old ? Give details of cost.

9. What steps would you take to deal with an outbreak of rinderpest in a herd under your charge ?

10.* What treatment would you give to a buffalo which had knocked its horn off in a fight ?

PAPER II.

N.B.—(1) Answer only *three* questions of each section.

(2) Questions marked with * are compulsory.

(3) Each section to be answered on a separate paper.

Section A—Dairy farm management.

1. Give a system of rotation of crops for a mixed farm on an unirrigated land in any part of India you are familiar with, assuming that one-third of the available crop should be fodder for dairy cows. Name the district your answer applies to and give the normal rainfall of that district.

2.* Describe any two methods of fodder conservation you are acquainted with, and give in detail the cost of harvesting and conserving any particular fodder by one of the methods you describe.

3. What quantity of water (in cusecs or gallons) is required to provide one inch of water on one acre of land, and what quantity of water could one pair of fit Indian bullocks weighing 800 lb. each raise per hour by any Indian system of water raising you are familiar with against a head of 25 feet? Show calculations in detail.

4.* Give a rough sketch with dimensions of ground plan, cross section and one elevation of a modern cow shed to accommodate 60 cows, and state the materials you would use in the construction of such a building.

Section B—Milk production, handling, etc.

5. What are the advantages of milk recording and disadvantages if any? Give headings of what you would consider an ideal milk record book for large herds.

6.* Why has milk pasteurizing been so universally adopted by the milk distributing trade throughout the world? Describe what you consider to be the ideal method of pasteurizing new milk for sale in large city dairies?

7. At what temperature should pasteurized milk be kept in cold store which is required to be good for retail sale after 48 hours' storage? How would you treat this milk and in what sort of package would you despatch it for a four hours' railway journey in the hot weather in India?

8.* If you were called upon to inaugurate an advertising campaign to encourage the use of fresh milk in Indian cities, what special points would you emphasize and why?

PAPER III.

- N.B.—(1) Answer only *three* questions of each section.
 (2) Questions marked with * are compulsory.
 (3) Each section to be answered on a separate paper.

Section A—Dairy buildings.

1. What system of drainage and sewage disposal would you recommend at a butter factory situated in a cultivated area where no outlet to stream or river was possible ?

2.* Describe in detail any system of cold storage construction and insulation you are familiar with.

3.* Draw a sketch plan (ground plan and one elevation) giving dimensions of a dairy building suitable for making butter and casein (hand power plant) at a dairy farm having 100 buffaloes in milk. State the materials you would use in construction.

4. What are the main points to be observed in designing a retail shop for the sale of milk in a large city ?

Section B—Dairy and farm engineering.

5.* Give a descriptive list of the cultivating, harvesting, and food preparing machines you would use on an irrigated farm of 100 acres of free loam used solely for fodder production for dairy cows.

6. What are the advantages and disadvantages of a steam engine as a prime mover in a dairy farm as compared with an oil (internal combustion) engine ?

7.* Describe any two types of milk pasteurizing machinery you are acquainted with and give the advantages and disadvantages of each.

8. What is the principle on which all mechanical refrigerators on the compression system work, and what is the essential difference in the construction of a compression refrigerating plant working with ammonia as the refrigerant as compared with a machine using CO_2 ?

PAPER IV.

Examination in cheese, butter and ghi manufacture and utilization of dairy products.

- N.B.—(1) Answer only *six* questions.
 (2) Questions marked with * are compulsory.

1. Describe in detail the process of manufacture of cheddar or other hard cheese from the cutting of the curd until the cheese is placed on the shelf in the ripening room.

2.* Draw up a detailed statement of the cost of manufacture of ripened cheddar cheese per lb. made from cows' milk in India, assuming that pure new milk costs you annas $1\frac{1}{2}$ per lb.

3. Why is cold storage necessary for the ripening of hard cheese in India ?

4. What are the advantages and disadvantages of ripening cream for butter making ? Describe how you would prepare a starter (pure culture) for cream ripening in India.

5.* Why is salt added to butter ? Describe an ideal method of salting butter, giving percentage of salt you would recommend by weight.

6.* What is *ghi* ? Describe what you consider an ideal process for its manufacture from butter. State what you know about the adulteration of *ghi* in India.

7.* What is meant by "commercial" casein, "rennett" casein, and "lactic" casein ? Describe the process of manufacture of any of these.

8. Describe any two systems of drying separated milk and state the advantages and disadvantages of each.

PAPER V.

N.B.—(1) Answer only *four* questions of each section.

(2) Question marked with * are compulsory.

(3) Each section to be answered on a separate paper.

Section A—Feeds and feeding.

1. Why are a number of different substances classed together as carbohydrates ? Give examples.

2.* What is the function of proteins in the ration of a mature resting bullock, and in the ration of a growing calf ?

3. What is the source of energy expended by animals ?

4.* What points have to be observed in computing a ration for a cow in milk ?

5. What body constituents would an animal draw upon when subjected to partial starvation ?

Section B—Dairy Chemistry and Dairy Bacteriology.

6. State what you know of the way in which adulteration is practised in the case of milk, butter and cream ? How far may you be able to detect adulteration in these cases ?

7.* Give an average analysis of cow's milk? Under what circumstances, if any, might the milk yield of a herd fall below this standard?

8. Give a list of the sources from which bacteria are brought into milk before its delivery to the consumer.

9.* Make a rough sketch of what you consider to be the best type of milk pail you have seen. State why it is better than an ordinary galvanized iron bucket.

10. Bottles of pasteurized milk supplied by your dairy do not keep well. The milk curdles, and the curd is gassy. What would you suspect to be the most likely cause of this defect?

PAPER VI.

N.B.—(1) All questions are compulsory.

(2) Each section to be answered on a separate paper.

Section A—Principles of co-operative dairying.

1. Why has the principle of co-operation been so successful in its application to dairy farming and creamery work in countries where land is worked by peasant proprietors owning small farms, and what has prevented the extension of this principle to dairying in India?

2. What preliminary survey is necessary before starting a co-operative milk producers' society?

3. State how you would proceed to form a co-operative milk consumers' society in a small town.

Section B—Dairy book-keeping.

4. Draw up a form of history sheet of a cow best suited to the needs of a modern dairy farm.

5. Name all the books and forms in detail which require to be written up on a modern dairy farm—(a) Daily, (b) Monthly, (c) Quarterly (d) Annually.

6. Name the particular books in which the following transactions might be shown in an ordinary commercial set of accounts for dairies (only names of books and forms to be given)—(a) 2 buffaloes died; (b) 3 delivery churns lost; (c) 12,000 lb. milk yielded by farm cattle;

(d) 100 lb. milk sold to a customer on credit in January, bill paid in February; (e) 50 buffaloes purchased from a contractor in January, bill paid in February; (f) 20 lb. milk supplied to a customer on coupons who bought a milk coupon book from the dairy for Rs. 3-12.

APPEN

Statement showing receipts and expenditure of the Imperial

Heads of receipts	TOTAL RECEIPTS	
	Cash	Book debit
	Rs.	Rs.
<i>Dairy produce</i>		
Credit	7,938	535
Cash	2,607	..
<i>Capital receipts</i>		
Live-stock (dairy)	96	3,392
Live-stock (draught)	29	..
<i>Miscellaneous receipts</i>		
Sales of skins	19	..
Grain and fodder	40,224	13,976
Miscellaneous	8,103	1,432
TOTAL .	59,016	19,335
COMBINED TOTAL Rs. .	78,351	

DIX II.

Cattle Breeding Farm, Karnal, for the year 1925-26.

Heads of expenditure	TOTAL EXPENDITURE	
	Cash	Book debit
	Rs.	Rs.
<i>Supplies and Services</i>		
Lands, improvements to lands and buildings . . .	13,796	..
Plant, machinery and implements	861	952
Purchase of dairy cattle, including replacements of casualties.	7,610	4,148
Purchase of draught animals	1,040	..
Feed of dairy cattle, including grazing charges . . .	18,231	89
Chemical and other manufacturing sundries . . .	10,467	29
Hire of cattle and purchase of dairy produce . . .	129	20
Production of grain and fodder and cultivation charges	6,353	8,527
Fuel, light, water and miscellaneous stores . . .	2,383	4
Workshop	2,323	47
Medical stores	71	660
Freight on stores	4,779	46
Rent and repairs of buildings	2,659	..
TOTAL	70,702	14,522
<i>Contingencies</i>		
Miscellaneous charges and refund of coupons . . .	1,792	466
<i>Establishment</i>		
Pay of officers	7,185	..
Pay of other establishment	17,067	189
Leave salary . . . . .	..	..
TOTAL	24,252	189
<i>Allowances</i>		
Travelling allowance of officers	1,633	..
" " other establishment . . .	868	..
TOTAL	2,501	..
GRAND TOTAL	99,247	15,177
COMBINED TOTAL Rs.	1,14,424	

APPENDIX III.

Outturn of grain and fodder from the Imperial Cattle Breeding Farm, Karnal, during the year 1925-26, as compared with the previous year.

Particulars	1924-25		1925-26		DIFFERENCE	
					Plus	Minus
	Md.	Sr. Ch.	Md.	Sr. Ch.	Md. Sr. Ch.	Md. Sr. Ch.
Gram (seed)	.	.	1,085	22 0	....	819 16 8
Barley	.	.	122	24 0	....	36 6 8
Wheat	.	.	893	5 0	....	....
Ziri	.	.	3,071	26 0	2,710 9 0	....
Wheat and gram (mixed)	.	.	723	10 0	2,024 26 0	....
Mustard seed	.	.	21	24 4	....	55 30 4
Oat seed	10 4 4	....
Toria
Maize	.	.	43	27 0	37 19 8	....
Gur	.	.	287	38 0	....	39 29 0
Sugarcane seed	202 17 0
Peas	2,274 30 0	....
Maize cobs	4 3 0	....
<i>Fodder</i>						
Feeding hay	.	.	lb.	lb.	lb.	lb.
Bhusa (mixed)	.	.	69,320	103,020	33,700	....
Green oats	.	.	95,132	325,027	229,895	....
Green grass	41,980	41,980	....
Dry chari	.	.	5,088	2,052,465	2,047,377	....
Oat straw	.	.	9,040	....	....	9,040
Wheat bhusa
Bedding hay	.	.	177,461	(included into mixed)	....	177,461

Total amount of rainfall during the year 1925-26 under report was 38.84 inches as against 34.93 inches in the previous year.

APPENDIX IV.

Produce Statement of Imperial Cattle Breeding Farm, Karnal, for the year ending 31st March 1926.

NUMBER OF GOVERN- MENT OWNED ANI- MALS IN MILK EACH DAY MULTIPLIED BY NUMBER OF DAYS IN YEAR.		AVERAGE YIELD OF GOVERNMENT OWNED ANIMALS IN MILK PER DAY		AVERAGE PERCENTAGE OF HERD IN MILK DURING YEAR		MILK						BUTTER						
		Cows	Buffa- loes	Cows	Buffa- loes	Pro- duced by Govern- ment owned herd	Pur- chased from all sources	Sold as new milk	Seps- rated	Cream pro- duced	Cream sold	Seps- rated milk pro- duced	lb. milk re- quired to make 1 lb. butter	Manu- fac- tured	Purchased. See note I		Average price paid per lb. of butter purchased	Ghi manu- factured
															From Govt. factories	From other sour- ces		
Cows	B fla- loes					lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	Re.	lb.
In milk	In milk	381	15-23	63-87	100	Cows	3,964	84,269	43,578	3,997	153	39,580	20-5	1,354	20	128	1	386
Dry	Dry					Buffaloes	From Septid milk 7,90 lb.	Steri- lized 49,543 lb.	Found surplus 5 lb.	On Butter outturn 1,292 lb.								
14,436						5,805	From steri- lized milk 2 lb.	To farm stock 22,070 lb.										

NOTE.—Any cream bought for churning purpose to be treated as purchase of butter and the quantity of butter yielded to be shown as butter purchased.

Disposal of produce at Imperial Cattle Breeding Farm,

NEW MILK			SEPARATED MILK			CREAM		
SOLD		Loss	Sold	Average price per lb.	Fed to farm stock	Sold	Average price per lb.	Loss
To officers and civilians and local customers	To farm employees							
lb.	lb.	lb.	lb.		lb.	lb.	Re.	lb.
49,544 @ As. 1								
3,661 @ As. 1½	2,003 @ As. 1	720	35	½ A.	19,403 To new milk	153 To other	1	3
30 @ As. 1½	9,642 @ As. 1½				5,977 Thrown away	farms on butter		
7,266 @ As. 1½					14,164	1,292 Sterilized		
12,122½ @ 20 lb. a rupee						1 Churned 2,548		

Stock in hand at beginning

	Cream
	lb.
At 1st April 1925	25
At 31st March 1926	29

DIX V.

Karnal, for the year ending 31st March 1926.

BUTTER			GHI		STERILIZED MILK RECEIPTS	
SOLD			Sold	Average price per lb.	Disposal	Total for dairy produce as shown in the Cash Book
To hospitals and prisons	To civilians and officers and local customers	To farm employees				
lb.	@ Rs. 1-4 per lb.	@ Rs. 1-4 per lb.	lb.	As.	lb.	Rs. A. P.
			Farm employees		Produced — 49,543	
	lb. 849	98	53	15	Sold— 7,896 @ As. 3 per lb. —20 per cent.	11,079 6 6
Churned 565	Cooking butter		147	14	19,337½ @ As. 4 per lb. —30 per cent.	
As sample 3	@ As. 15 12		172	14	12,535 @ As. 3 per lb. —25 per cent.	
Farm stock 1	@ As. 14 1½		To farm stock 1		165 @ As. 4 per lb. 208½ as samples. 1,702 to farm stock	
					7,843½ to loss. 2½ to fresh milk.	
					TOTAL 49,69 0 lb.	

and close of year.

Butter		Ghi		Sterilized milk	
lb.	oz.	lb.	oz.	lb.	oz.
32	2	18	12	1,521	0
4	8	30	10	1,374	4

APPENDIX VI.

Herd Statistics of Imperial Cattle Breeding Farm, Karnal, for the year ending 31st March, 1926.

	ADULT STOCK				YOUNG STOCK				CALVES			DRAUGHT CATTLE			
	COWS			BUFFALOES	COWS			BUFFALOES		COWS		COW BULLOCKS		BUFF BULLOCKS	PONIES
	Bulls	Cows		Cows	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Country	Halfbred			
		Jersey	Country										Country		
Strength of herd on 1st April 1925.	6	1	104	..	27	32	..	..	43	42	14	3	1	2
Born . . . . .	..	..	..	..	..	..	..	(With dams)	31	46	..	..	..	..
Purchased . . . . .	..	..	16	8	..	..	..	2	10	5	6	..	..	..
Average price paid for animals purchased including freight.	..	..	399-2-7	405-7-0	..	..	..	..	..	..	173-5-4	..	..	..
Transferred from—															
Other Government dairies	1	..	8	..	..	16	..	..	(With dams)	2	..	..	..	..
Young stock . . . . .	..	..	2	..	26	19	..	..	..	..	..	..	..	..
Calves . . . . .	..	..	..	..	38	34	..	..	..	..	..	..	..	..
Found surplus on the farm	..	..	..	..	..	..	..	..	..	..	..	..	1	..
TOTAL	7	1	130	3	91	101	1	2	92	95	20	3	2	2	
Transferred to—															
Other Government dairies	..	1	..	..	..	13	..	..	..	4	..	..	..	..
Adult stock . . . . .	..	..	..	..	2	2	..	..	..	..	..	..	..	..
Young stock . . . . .	..	..	..	..	19	19	..	..	..	..	..	..	..	..
Lost . . . . .	..	..	..	..	..	..	..	..	33	34	..	..	..	..
Died . . . . .	..	..	3	..	1	..	..	..	15	13	1	..	..	1
Sold . . . . .	..	..	3	..	..	..	..	..	1	..	2	..	..	..
Average price for animals sold.	..	..	36-0-0	..	..	..	..	..	With dams	..	14-8-0	..	..	..
TOTAL . . . . .	..	1	6	..	27	34	..	..	54	51	3	..	..	1
Strength of herd on 31st March 1926.	7	..	124	3	64	67	1	2	38	44	17	3	2	1	

APPENDIX VII.

Yield of cows which completed a lactation period during the financial year 1925-26, at Karnal.

Animal No.	Name	Approximate age on 31st March 1926	Milk yield	Days	REMARKS
	<i>Thar-Parkar breed.</i>	Years	lb.		
1	Bonnie	8	3,436	299	Calf tied at head.
2	Honey	9	3,759	272	
3	Floura	8	1,123	167	
3	Do.	8	748	111	
4	Fanny	8	2,030	294	
4	Do.	8	1,549	185	
5	Ann	8	369	101	
6	Bright	9	1,104	161	
6	Do.	9	1,083	206	
7	Fancy	9	1,857	302	
9	Girtie	8	2,409	273	
11	Hope	9	924	212	Had two male calves, not weaned.
12	Lassie	7	1,794	223	Aborted.
13	Hannah	8	1,625	279	
14	Lizzie	7	2,354	253	
14	Do.	7	940	168	
15	Kate	8	2,240	278	
16	Bella	9	1,846	306	
17	Pride	8	1,696	229	
18	Ruby	8	2,639	211	
18	Do.	8	30	34	
19	Ida	8	2,454	276	
21	Girtie	8	3,178	266	
22	Jean	9	2,163	282	
23	Bess	8	2,230	161	
24	Nell	7	1,273	212	
26	Betty	10	289	70	
27	Connie	8	2,144	163	
28	Biddy	8	2,241	283	
29	Rani	10	1,037	105	
30	Alpha	9	433	179	
32	Ruth	9	2,918	251	
33	Bibi	8	1,468	130	
35	Maira	8	890	141	
36	Jane	9	2,378	298	
37	Dhanbir	9	2,323	181	
39	Bhai	8	447	74	
40	Mercy	8	1,688	255	
41	Loyalty	9	1,820	252	
42	Fife	8	2,390	264	
43	Organ	8	94	264	
44	Artisti	9	5,109	336	
45	Horn	9	2,880	272	
46	Thrift	8	1,081	188	
47	Atma	8	1,564	262	
48	Asdal	8	1,976	187	

APPENDIX VII—*contd.*

Yield of cows which completed a lactation period during the financial year 1925-26, at Karnal—contd.

Animal No.	Name	Approximate age on 31st March 1926	Milk yield	Days	REMARKS
	<i>Thar-Parkar breed</i> — <i>contd.</i>	Years	lb.		
49	Collean . . .	9	1,890	221	Aborted.
50	Wish . . .	8	487	182	
51	Pita . . .	9	1,730	202	
51	Do. . .	9	56	19	
52	Promise . . .	9	526	132	
53	Mamre . . .	9	2,996	283	
54	Disdain . . .	11	483	60	
55	Dhana . . .	9	1,730	310	
57	Malaga . . .	8	819	203	
59	Priscilla . . .	8	2,464	249	
60	Hornie . . .	10	557	85	
61	Spinet . . .	10	3,210	293	
62	Violet . . .	10	4,827	408	
63	Laura . . .	9	1,420	323	
65	Patsie . . .	10	3,173	261	
67	Nanni . . .	9	2,133	246	
69	Begam . . .	9	2,205	245	
70	Irixie . . .	9	297	93	
71	Nora . . .	9	2,610	286	
72	Starlight . . .	9	1,440	385	
75	Matchless . . .	8	2,696	398	
	<i>Hariana breed.</i>				
73	Ada . . .	9	1,090	199	Aborted.
73	Do. . .	9	238	89	
76	Bilinda . . .	10	2,262	342	
77	Carnation . . .	5	1,627	195	
78	Dora . . .	8	2,370	369	
79	Effie . . .	9	898	194	
80	Fay . . .	8	1,205	325	
81	Gladys . . .	8	2,129	405	
82	Hanna . . .	7	1,629	298	
83	Irisis . . .	9	2,030	369	
84	Jill . . .	7	762	180	
85	Lila . . .	7	1,444	279	
86	Mary . . .	6	504	155	
87	Nettie . . .	5	952	271	
88	Opal . . .	6	2,217	388	
89	Queenie . . .	7	2,154	321	
90	Ruby . . .	10	1,783	349	
91	Joan . . .	8	653	175	
92	Lucy . . .	9	766	187	
93	Maggie . . .	6	1,488	310	
94	Milkmaid . . .	8	1,725	330	
95	Buttercup . . .	7	1,148	248	
96	Latchmi . . .	8	206	56	

APPENDIX VII—*concl'd.*

Yield of cows which completed a lactation period during the financial year 1925-26, at Karnal—concl'd.

Animal No.	Name	Approximate age on 31st March 1926	Milk yield	Days	REMARKS
	<i>Hariana breed— contd.</i>	Years	lb.		
97	Susan . . .	7	1,520	294	
98	Vic . . .	7	1,025	244	
100	Charlotte . . .	6	3,099	312	
101	Cawnpore Anne . .	11	2,822	286	
102	Cawnpore Baroness	7	2,525	253	
104	„ Officer . .	5	2,166	258	
105	„ Betty . .	5	909	212	
106	„ Kate . .	5	898	160	
107	„ Rosebud . .	6	21	25	
108	„ Iris . .	6	3,133	347	
109	Wonder . . .	5	4,577	358	
110	Hope . . .	5	3,023	271	
	<i>Thar-Parkar breed.</i>				
111	Goodie . . .	5	508	125	
112	Garrie . . .	9	377	124	
122	Rhoda . . .	8	223	111	
123	Daisy . . .	9	95	49	

APPEN

Statement showing receipts and expenditure under different budget heads of
for

Heads of receipts	TOTAL RECEIPTS					
	Cash			Book debit		
	Rs.	A.	P.	Rs.	A.	P.
<i>Dairy produce</i>						
On credit	77,927	13	11	12,094	0	4
„ cash	9,852	14	9	....	
„ coupons	24,470	1	3	....	
TOTAL .	1,12,250	13	11	12,094	0	4
<i>Capital receipts</i>						
Live-stock, dairy	10,906	4	0	460	0	0
„ draught	121	0	0	....	
Plant and machinery	70	0	0	1,931	0	0
TOTAL .	11,097	4	0	2,391	0	0
<i>Miscellaneous receipts</i>						
Grain and fodder	392	14	1	452	2	8
Other miscellaneous receipts	6,985	5	4	2,032	9	2
Fees from students	3,515	0	0	180	0	0
TOTAL .	10,893	3	5	2,664	11	10
GRAND TOTAL .	1,34,241	5	4	17,149	12	2
COMBINED TOTAL Rs. .	1,51,391 1 6					

DIX VIII.

the Imperial Institute of Animal Husbandry and Dairying, Bangalore, 1925-26.

Heads of expenditure	TOTAL EXPENDITURE	
	Cash	Book debit
	Rs. A. P.	Rs. A. P.
<i>Supplies and services</i>		
Lands, buildings and accessories	11,782 14 0	....
Plant and machinery	7,489 14 0	1,737 3 0
Purchase of dairy cattle	7,157 9 1	4,292 8 0
TOTAL OF CAPITAL ITEMS .	26,430 5 1	6,029 11 0
Rent and repairs to buildings	941 12 11	....
Repairs to plant and machinery	4,707 10 3	....
Feed of dairy cattle	42,836 3 1	1,205 11 6
Purchase of dairy produce	27,902 12 5	398 13 0
Ice, salt and other preservatives	751 10 0	....
Cultivation charges	426 0 0	....
Fuel, light, water and miscellaneous stores	13,872 11 11	46 4 3
Freight on stores	2,333 6 0	967 2 0
TOTAL OF REVENUE ITEMS .	93,772 2 7	2,617 14 9
<i>Contingencies</i>		
Miscellaneous charges and refund of deposits .	6,210 11 2	743 14 2
<i>Establishment</i>		
Pay of officers	11,081 5 0	....
Pay of other establishment	24,894 9 0	....
TOTAL .	35,975 14 0	....
<i>Allowances—T. A. and motor cycle</i>		
Gazetted officers	1,077 8 0	....
Non-gazetted officers	913 4 0	....
Honoraria	68 0 0	....
TOTAL .	2,058 12 0	....
GRAND TOTAL .	1,64,447 12 10	9,391 7 11
COMBINED TOTAL Rs.	1,73,839 4 9	

APPENDIX IX.

Statement showing outturn of fodder at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the year ending 31st March 1926.

Where grown	Description of fodder	Outturn in lb.	REMARKS
Bangalore	Green Guinea grass .	394,590	The whole quantity except 18,000 lb. converted into silage, was issued for daily rations throughout the year.
	„ Lucerne .	262,770	Issued for daily rations throughout the year.
	„ jowar . .	892,700	Out of this 741,000 lb. were converted into silage and the balance issued as daily rations from August to November 1925.
	Dry jowar . .	23,345	Issued for daily rations from December 1925 to February 1926.
	TOTAL .	Green 1,550,060 Dry 23,345	
Bommanpall'	Green jowar . .	140,500	Out of this, 55,000 lb. were conveyed to Bangalore and converted into silage, 63,000 lb. were converted into silage at Bommanpalli and the balance of 22,500 lb. were issued for daily rations.

APPENDIX X.

Produce Statement of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the year ending 31st March 1926.

NUMBER OF GOVERNMENT OWNED ANIMALS IN MILK EACH DAY MULTIPLIED BY NUMBER OF DAYS IN YEAR		AVERAGE YIELD OF GOVERNMENT OWNED ANIMALS IN MILK PER DAY		AVERAGE PERCENTAGE OF HERD IN MILK DURING YEAR		MILK								BUTTER				
Cows	Buffaloes	(Cows)	Buffaloes	Cows	Buffaloes	Produced by Government owned herd	Purchased from all sources	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	Lb. milk required to make 1 lb. butter	Manufactured	Purchased (See Note I)		Average price paid per lb. for butter purchased	Cheese manufactured
															From Govt. farms	From other sources		
In milk	In milk	In milk	In milk			Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Rs. a. p.	Lb.
38,666	1,367	14.4	20.0	69.0	75.3	Cows 5,57,720	4,559	3,58,574	65,691	6,569	1,742	59,122	20	2,422	105	24,357	1 2 0	8,774
Dry	Dry	All over herd	All over herd			Buffaloes 27,407			Cheese making 105,280						From Wellington Institute	From Anand 128		
17,292	448	9.97	15.1															

NOTE I.—Any cream bought for churning purpose to be treated as purchase of butter and the quantity of butter yielded to be shown as butter purchased.
NOTE II.—Fractions of 1 lb. may be omitted.

APPENDIX XII.
Herd Statistics of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the year ending 31st March, 1926.

	ADULT STOCK						YOUNG STOCK						CALVES				DRAUGHT CATTLE			
	COWS			BUFFALOES			COWS			BUFFALOES			COWS		BUFFALOES		Cow bullocks	Buff bullocks	Mules	Ponies
	Bulls	Cows	Bulls	Cows	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers								
Number in herd on 1st April, 1925.	6	163	1	5	13	49	3	2	16	39	2	2	22	1	2	10				
Born during year .	..	..	..	..	..	..	..	..	69	63	..	..	..	..	..	..	..	..	..	..
Purchased during year.	2	14	..	..	..	..	..	..	6	4	..	..	..	..	..	..	..	..	..	..
Received by transfer from other farms and departments.	..	1	..	..	..	17	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heifers transferred to milking herd.	..	13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bulls added to herd from young stock for stud purposes.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bulls added to herd from young stock for draught purposes.	..	..	..	..	17	49	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calves transferred to young stock.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
TOTAL	8	191	3	5	30	115	3	2	91	106	2	3	23	1	2	10				
Transferred to other farms.	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Died .	..	22	..	..	..	28	..	..	58	30	..	..	..	..	..	..	..	..	..	..
Sold .	2	28	..	..	..	32	..	..	3	6	..	..	..	..	..	..	..	..	..	..
Destroyed	..	6	..	..	..	2	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Calves transferred to young stock	..	..	..	..	..	..	..	..	17	49	..	..	..	..	..	..	..	..	..	..
Young stock transferred to Adult Stock.	..	..	..	..	1	13	2	..	..	..	..	..	..	..	..	..	..	..	..	..
TOTAL	3	56	..	..	1	75	2	..	79	85	..	..	6	..	..	..	..	..	..	..
Balance on 31-3-26	5	135	3	5	29	40	1	2	12	21	2	3	17	1	2	9				

APPENDIX XIII.

*Yield of all cows and buffaloes which completed a lactation period during
1925-26 at Bangalore.*

No. of cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
523	H. B. Ayr. Sahiwal	10	13,066	386
133	H. B. Ayr. Hissar	17	9,071	240
711	H. B. Ayr. Hansi	10	8,385	334
821	H. B. Ayr. Scindi	9	8,793	451
2	Murra Buffalo	10	8,388	368
1	Do.	10	8,489	359
4	Do.	10	8,307	344
3	Do.	10	7,237	381
336A	H. B. Hol. Scindi	5	7,172	300
379A	H. B. Ayr. Scindi	4	7,010	333
766	$\frac{3}{4}$ Ayr. Hansi	10	7,311	295
834	Half Bred	10	6,430	256
927	H. B. Ayr. Scindi	8	6,527	285
967	H. B. Ayr. Sahiwal	7	6,085	353
434	$\frac{3}{4}$ Ayr. Hissar	12	6,351	253
5	Murra Buffalo	10	6,403	389
858	H. B. Ayr. Sahiwal	9	5,744	249
888	H. B. Ayr. Hansi	8	5,514	387
903	H. B. Ayr. Scindi	8	5,193	255
812	H. B. Ayr. Sahiwal	9	5,266	246
961	Do.	8	5,019	263
975	Do.	7	5,268	245
179A	H. B. Ayr. Scindi	7	5,313	341
189A	Do.	6	5,187	270
326A	H. B. Ayr. Scindi	5	5,610	299
332A	H. B. Ayr.	5	5,686	358
346A	H. B. Ayr. Scindi	5	5,808	304
388A	H. B. \times H. B. Ayr. Scindi cross . .	4	5,685	361
171A	$\frac{3}{4}$ Ayr. Sahiwal	7	5,260	391
11	Scindi	7	5,742	328
251A	H. B. Ayr. Scindi	6	4,912	231
378A	H. B. Ayr. Sahiwal	4	4,972	357
192A	$\frac{3}{4}$ Ayr. Hissar	6	4,918	330
14	Scindi	11	5,312	397
440	H. B. Ayr. Sahiwal	12	4,296	269
495	Do.	11	4,665	301
822	H. B. Ayr. Scindi	9	4,334	231
829	Do.	9	4,433	244
918	Do.	8	4,318	246
972	H. B. Ayr. Sahiwal	7	4,349	301
100A	H. B. Ayr. Scindi	7	4,494	304
218A	Do.	6	4,418	270
243A	Do.	6	4,361	289
295A	Do.	5	4,010	257
359A	Do.	4	4,087	252
363A	Do.	4	4,653	306
828	$\frac{3}{4}$ Ayr. Hissar	9	4,092	289
173A	Do.	7	4,861	333
309A	$\frac{3}{4}$ Ayr. Scindi	5	4,188	332
344A	Do.	5	4,424	320

APPENDIX XIII—contd.

Yield of all cows and buffaloes which completed a lactation period during 1925-26 at Bangalore—contd.

No. of cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
352A	$\frac{3}{4}$ Hol. Ayr. Scindi	5	4,772	444
353A	$\frac{1}{4}$ Ayr Sahiwal	5	4,768	294
372A	$\frac{1}{2}$ Hol. Sahiwal Scindi	4	4,461	345
4	Scindi	7	4,023	255
43	Do.	12	4,109	332
344	Half Bred	13	3,982	264
406	H. B. Ayr. Hansi	13	3,789	237
459	H. B. Ayr. Sahiwal	11	3,810	250
955	H. B. Ayr. Scindi	8	3,675	245
962	Do.	8	3,785	260
997	Do.	7	3,642	295
78A	Do.	9	3,618	269
188A	Do.	6	3,306	248
235A	Do.	6	3,118	286
236A	Do.	6	3,636	262
263A	Do.	6	3,179	285
268A	H. B. Ayr. Scindi	6	3,782	302
328A	Do.	5	3,852	318
364A	Do.	4	3,695	304
377A	Do.	4	3,007	249
786	$\frac{3}{4}$ Ayr. Hansi	10	3,253	244
207A	$\frac{3}{4}$ Ayr. Shorthorn Scindi	7	3,078	219
354A	$\frac{1}{2}$ Ayr. Sahiwal	5	2,929	283
1	Scindi	8	3,094	184
2	Do.	7	3,593	227
8	Do.	8	3,272	211
13	Do.	8	3,322	255
16	Do.	7	3,168	215
20	Do.	7	3,254	160
896	H. B. Ayr. Scfndi	8	2,525	259
280A	Do.	6	2,713	207
308A	Do.	5	2,174	252
314A	Do.	5	2,048	262
2	Jersey	7	2,017	296
204A	$\frac{3}{4}$ Ayr. Scindi	8	2,990	276
226A	Do.	7	2,768	203
301A	Do.	5	2,640	280
304A	Do.	5	2,339	228
373A	Do.	4	2,520	320
3	Scindi	9	2,647	206
5	Do.	7	2,412	188
6	Do.	9	2,516	230
7	Do.	7	2,809	298
12	Do.	7	2,143	204
22	Do.	9	2,712	220
26	Do.	7	2,269	200
29	Do.	9	2,565	170
31	Do.	9	2,989	270
33	Do.	9	2,049	220
39	Do.	7	2,475	282

APPENDIX XIII—*concl'd.*

*Yield of all cows and buffaloes which completed a lactation period during
1925-26 at Bangalore—contd.*

No. of cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
40	Scindi	7	2,892	213
41	Do.	8	2,695	220
42	Do.	10	1,540	170
375A	H. B. × H. B. Scindi Ayr. cross .	4	1,706	220
15	Scindi	7	1,726	165
17	Do.	8	1,719	179
21	Do.	7	1,853	153
25	Do.	7	1,473	170
30	Do.	10	1,780	200
32	Do.	9	1,048	139
36	Do.	9	1,802	180
37	Do.	7	1,524	152
44	Do.	8	1,162	102
9	Do.	7	631	87
23	Do.	8	723	84
34	Do.	7	511	84
38	Do.	8	302	84

APPENDIX XIV.

Statement of receipts and expenditure for the year
1925-26 of the Imperial Institute of Animal Hus-
bandry and Dairying, Wellington.

APPENDIX

Statement of receipts and expenditure for the year 1925-26 of the Imperial

HEADS OF RECEIPTS	TOTAL RECEIPTS
	Rs. A. P.
<i>Dairy produce</i>	
On credit	50,768 3 9
„ cash	8,388 5 9
„ coupons	15,009 7 9
<i>Miscellaneous receipts</i>	
Buildings	18 2 0
Live-stock	4,475 0 0
Grain and fodder	2,876 0 10
Miscellaneous receipts	2,071 8 0
House-rent	306 0 0
GRAND TOTAL .	83,912 12 1

DIX XIV.

Institute of Animal Husbandry and Dairying, Wellington.

HEADS OF EXPENDITURE	TOTAL EXPENDITURE
<i>Supplies and services</i>	
Lands, improvements to lands, buildings and accessories	3,006 8 0
Plant, machinery and implements	3,463 15 0
Purchase of dairy cattle including replacement of casualties	11,724 4 0
Rent and repairs to buildings including taxes	953 8 2
Repairs to plant and machinery	470 6 0
Feed of dairy cattle including grazing charges	24,332 1 8
Hire of cattle and purchase of dairy produce	33,800 8 11
Chemicals and other manufacturing sundries	132 10 0
Production of grain and fodder (cultivation charges)	2,000 6 0
Fuel, light, water, and miscellaneous stores	3,306 6 6
Medical stores	235 10 0
Freight on stores	932 8 0
TOTAL	84,358 12 3
<i>Contingencies</i>	
Miscellaneous charges	1,115 7 9
Service stamps	350 0 0
TOTAL	1,465 7 9
<i>Establishment</i>	
Pay of officers	{ 4,078 3 6 2,883 14 0 4,021 1 0
Pay of other establishment	{ 871 0 0 7,481 13 0
Leave-salary	104 13 0
TOTAL	19,440 12 6
<i>Allowances, etc.</i>	
Travelling and motor cycle allowances of officers	594 15 0
House rent and other allowances	120 0 0
TOTAL	714 15 0
GRAND TOTAL	1,05,979 15 6

APPENDIX XV.

Outturn of grain and fodder crops of the Imperial Institute of Animal Husbandry and Dairying, Wellington, during 1925-26.

TOTAL AREA OF THE LAND IN POSSESSION OF THE DAIRY			1925-26							REMARKS
Arable	Grazing	Building site	Total area of land under cultivation	Total out-turn in green	Total expenditure incurred on cultivation	Production rate per 100 lb.	Total fodder purchased in green	Total amount paid for purchased fodder	Average purchase rate per 100 lb.	
Acres	Acres	Acres	Acres	lb.	Rs. A. P.	Rs. A. P.	lb.	Rs. A. P.	Rs. A. P.	
15.10	40.61	6.08	14.75	5,55,235	2,000 6 0	0 5 9	313,950	4,447 10 0	1 6 8	Purchased as dry fodder and reduced in terms of green.
							121,602	1,439 6 0	1 4 0	
		Forest land for fuel about 7 acres.					10,535	176 11 0	1 6 8	Purchased as green fodder.

APPENDIX XVI.

Produce Statement of the Imperial Institute of Animal Husbandry and Lactation, Wellington, for 1925-26.

Number of animals in milk each day multiplied by number of days in year	Average yield of animals in milk per day	Average percentage of herd in milk during year	MILK						BUTTER			CHEESE				
			Pro-duced by Govern-ment owned herd	Pur-chased from all sources	Sold as new milk	Sepa-rated	Cream pro-duced	Cream sold	Sepa-rated milk pro-duced	lb. milk required to make 1 lb. butter	Purchased			Average price paid per lb. for butter pur-chased	Pur-chased from Govt. farms	Average price paid per lb. pur-chased
											Manu-fac-tured	From Govt. farms	From other source			
Cows	Cows	Cows	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	Rs. A. P.	lb.	Rs. A. P.	
In milk 14,222	Over herd in milk 13.6 lb.	67.6	194,299	35,523	191,295	24,210	1,869	1,194	22,341	25	348	1,140	19,079	1 2 9	1,096	1 5 8
Dry 6,803	Over whole herd 9.2 lb.															

APPENDIX XVII.

Disposal of produce of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for 1925-26.

NEW MILK				SEPARATED MILK			CREAM		BUTTER				CHEESE		RECEIPTS		
SOLD				Loss	Sold	Average price per lb.	Fed to farm stock	Sold	Average price per lb.	SOLD			Loss	Sold	Average price per lb.	Loss	Total for dairy produce as shown in the cash book
To hospitals and prisons	To officers and civilians	To troops	To hospitals and prisons							To civilians and officers	To troops						
@ As. 4 per lb.	@ As. 4 per lb.	@ As. 3½ per lb.	lb.	lb.	Rs. A. P.	lb.	Rs. A. P.	lb.	Rs. A. P.	lb.	Rs. A. P.	lb.	Rs. A. P.	lb.	Rs. A. P.	lb.	Rs. A. P.
34,309 lb.	20,892 lb.	79,546 lb.	2,248	@ As. 2 per lb.		180 lb.		1,194	1-12-0	1,467 lb.	4,862 lb.	12,030 lb.		@ Rs. 1-12-0 per lb.			
Civil hospital, Coonor.		Families @ As. 2½ per lb.		@ A. 1 per lb.	0-1-1	19,639				@ Rs. 1-10-0 per lb.	lb. @ Rs. 1-8-0 per lb.	2,016 lb. families @ Rs. 1-6-0 per lb.	2	@ Rs. 1-8-0 per lb.	1-1-½	66	74,166-1-3
@ As. 3½ per lb.				2,500 lb.				Churned 680		Fed to farm stock—28 lb.							
15,789 lb.		40,759 lb.		@ 10 lb. per B.													
Separated 24,210 lb.																	
Fed to farm stock—11,997 lb.																	

Stock in hand at beginning and close of year.

		New milk		Cream		Butter		Cheese	
At 1st April 1925.	.	lb.		lb.		lb.		lb.	
At 31st March 1926	.	95		9		128		156	
	.	167		4		288			

APPENDIX XVIII.

Herd Statistics of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for 1925-26.

	ADULT STOCK		YOUNG STOCK		CALVES		DRAUGHT CATTLE	
	Cows		Cows		Cows		Cow bullocks	Ponies
	Bulls	Cows	Bulls	Helpers	Bulls	Helpers		
Strength of herd on 1st April 1925	4	54	3	19	1	10	14	3
Born . . . . .	..	..	..	..	21	18	..	..
Purchased . . . . .	..	24	..	..	4	10	..	..
Average price paid for animals purchased including freight .	..	Rs. 458-7-0	..	..	..	..	..	..
Transferred from—								
Other Government dairies	1	..	..	..	..	..	..	..
Young stock . . . . .	..	5	..	..	..	..	..	..
Calves . . . . .	..	..	1	9	..	..	..	..
TOTAL	5	88	4	28	26	38	14	3
Transferred to—								
Other Government dairies . . . . .	..	..	..	..	..	..	..	..
Adult stock . . . . .	..	..	..	5	..	..	..	..
Young stock . . . . .	..	..	..	..	1	9	..	..
Lost . . . . .	..	..	..	..	..	..	..	..
Died . . . . .	..	5	..	..	5	10	1	..
Sold	1	2	2	10	18	9	..	..
Average price for animals sold	Rs. 300-0-0	Rs. 45-0-0	Rs. 1,175-0-0	Rs. 189-8-0	Rs. 1-8-0	Rs. 37-7-0	..	..
TOTAL	1	7	2	15	24	28	1	..
Strength of herd, 31st March 1926	4	76	2	13	2	10	13	3

APPENDIX XIX.

Statement showing yields of cows who completed a lactation period at Wellington in the year 1925-26.

Name and No. of cow	Breed	Age at end of lactation period	Quantity of milk given during lactation	No. of days required for lactation	REMARKS	
					Previous yield	Cause for shortage of yield
			lb.		lb.	
Amber 1 .	Ayr. Scindi	16½	8,676	363		
Aster 4 . .	Do. . .	15½	7,508	469		
Belle 7 . .	Do. . .	15½	4,978	409		
Brittania 11 .	Shorthorn Scindi	15	6,421	383	7,283	Contagious abortion
Julia 14 . .	Ayr. Scindi	15½	3,855	327	4,616	Do.
Anne 18 . .	Do. . .	13½	3,456	260		
Marie 23 . .	Do. . .	13½	3,604	295	4,252	Do.
Charlotte 32 .	Do. . .	12½	3,970	274	6,757	Do.
Vijaya 32A .	Scindi . .	6½	2,477	230	3,551	Do.
Grace 40 . .	Ayr. Scindi .	11½	9,528	367		
Doris 42 . .	Do. . .	10½	2,929	225		
Laxmi 48 . .	Scindi . .	4½	1,805	167		
Karani 44 . .	Do. . .	6½	1,870	148		
Vimala 45 . .	Do. . .	5½	2,027	148		
Sita 46 . . .	Do. . .	5½	1,133	148		
Radha 48 . .	Do. . .	5½	1,658	205		
Valli 49 . . .	Do. . .	5½	468	75		
Ooma 50 . . .	Do. . .	4½	1,166	116		
Molly 110 . .	H.B.Ayr.Sahiwal	10½	3,437	248		
Pansy 111 . .	H.B.Shorthorn Scindi	10½	5,678	312	5,936	Do.
Queen 112 . .	½ Ayr. Scindi .	9½	5,034	284		
Pearl 114 . .	Ayr. Scindi . .	8	4,295	287		
Ruby 113 . .	Do. . .	8½	4,605	296		
Helen 118 . .	Do. . .	8½	3,027	241		
Tulip 120 . .	½ Ayr. Sahiwal .	7½	4,199	304		
Nelly 123 . .	Ayr. Scindi . .	7½	3,004	243		
Clara 124A . .	H. B. × H. B. .	3½	2,932	249		
Benita 125A .	¾ Ayr. Scindi .	3	1,964	200		
Elizabeth 139A .	H. B. × ½ . .	3	2,333	230		
Rose 150 . . .	H. B. × H. B. .	3½	1,126	162		
Kato 159A . .	Ayr. Scindi . .	6½	2,028	271	4,660	Do.
Mary 209A . .	½ Ayr. . .	6	6,026	292		
Elleen 228A .	H. B. Ayr. Scindi	5½	3,955	322		
Lavender 258A .	Do. . .	5½	4,968	297		

APPENDIX XIX—contd.

Statement showing yields of cows who completed a lactation period at Wellington in the year 1925-26—contd.

Name and No. of cow	Breed	Age at end of lactation period	Quantity of milk given during lactation	No. of days required for lactation	REMARKS	
					Previous yield	Cause for shortage of yield
			lb.		lb.	
Maude 415 . .	H. B. Ayr. Hansi	11	6,714	410		
Sadie 590 . .	Ayr. Scindi .	9½	3,147	235		
Bess 706 . .	Do. . .	8½	4,381	308	5,569	Contagious abortion
Dolly 709 . .	Ayr. Sahiwal .	9½	7,842	387	9,270	Do.
Ruth 830 . .	Ayr. Hansi .	8½	5,807	329		
Butterfly 838 .	H. B. Ayr. Scindi	8½	4,157	116		
Madge 857 . .	Ayr. Sahiwal .	8	6,035	320		
Poipy 924 . .	¾ Ayr. Sahiwal .	7½	6,245	385		
Ivy 948 . .	Do. . .	7½	4,096	263		
Frien/less-head. queen 11.	Ayreshire .	4½	2,938	312	3,612	Do.
Glensham rock Rossie 3rd IV.	Do. . .	4½	4,758	444		

Statement showing receipts and expenditure of the

Heads of receipts	Total receipts
<i>Revenue receipts</i>	Rs. A. P.
Dairy produce—	
On credit	8,735 15 8
On cash	577 9 0
Miscellaneous	303 5 6
Fees from students	220 0 0
Other miscellaneous receipts	114 7 0
TOTAL .	*9,951 5 2
 *Total receipts for the period	 9,951 5 2
Amount due to creamery on 31st March 1926	7,563 10 8
Value of stock in hand	19,895 10 3
TOTAL .	37,410 10 1

DIX XX.

Government Creamery, Anand, for the period ending 31st March 1926.

Heads of expenditure	Total expenditure
REVENUE EXPENDITURE	
<i>Supplies and services</i>	Rs. A. P.
Rent and repairs to buildings	£ 1,076 15 0
Plant, machinery and implements	1,998 11 0
Purchase of dairy produce	26,488 14 9
Chemicals and other manufacturing sundries	771 1 0
Workshop	351 12 6
Fuel, light, water and miscellaneous stores	9,153 7 6
Freight on dairy produce	1,736 8 0
<i>Contingencies</i>	
Miscellaneous expenses	562 9 9
<i>Establishment</i>	
Pay of officers	3,022 5 6
Pay of establishment	2,209 1 3
<i>Allowances</i>	
T. A. of gazetted officers	1,013 1 0
T. A. of establishment	190 5 0
TOTAL OF REVENUE EXPENDITURE .	48,574 12 3
CAPITAL EXPENDITURE	
New Boiler	£ 6,775 12 0
GRAND TOTAL .	£ 55,350 8 3

APPENDIX XXI.

Produce Statement of the Government Creamery, Anand, for the period from 13th October 1925 to 31st March 1926.

MILK					BUTTER		
Purchased from all sources	Sold as new milk	Separated	Cream produced	Separated milk produced	Purchased See note I. From contractor	Average price paid per lb. for butter purchased	Ghi manufac- tured
lb.	lb.	lb.	lb.	lb.	lb.	Rs. A. P.	lb.
1,430	940	450	45	402	Special	0 14 7	95
					1,041		
					" A "		
					26,550	0 14 3	
					" B "		
					1,859	0 13 5	
				TOTAL	29,450	0 14 2	

NOTE I.—Any cream bought for churning purpose to be treated as purchase of butter and the quantity of butter yielded to be shown as butter purchased.

NOTE II.—Fractions of a lb. may be omitted.

REPORT OF THE PHYSIOLOGICAL CHEMIST.

(F. J. WARTH, M.Sc.)

I. CHARGE AND STAFF.

Charge. I was in charge of the Section throughout the year.

Staff. Mr. A. V. Iyer, First Assistant to the Physiological Chemist, was on privilege leave from 7th April to 5th June, 1926, and Mr. N. C. Das Gupta officiated as First Assistant during that period.

II. EXTENSION AND IMPROVEMENT.

When the last report was submitted the laboratory had been working for one year and was far from perfectly fitted up. Since then considerable progress has been made with fittings and in laboratory organization. The result is that a greater output of laboratory work has been possible during the past year, and consequently the Section has been able to carry out more feeding tests under chemical control. The feature of the year's work is, in fact, the great expansion in feeding experiments. Another feature which will become evident in the course of the report is that the study of animal nutrition has been taken up in a more comprehensive manner. This has been made possible by the increased laboratory resource of the Section.

One feature is not so satisfactory. There has been no progress in the enquiry on milk production. For the proposed work continuity was an essential condition and during the past year continuity could not be assured. Further construction has, however, recently been sanctioned by Government. With the additional facilities which the new buildings will provide, it should be possible to take up this most important subject systematically.

III. LABORATORY WORK.

Testing of methods has been continued in connection with storage of fæces and analysis of silage and urine. The bulk of the analytical work was directly connected with feeding experiments. The following is a list of the analyses completed during the year :—

Complete analyses—fodders	77	
Ditto fæces	69	
	<hr/>	146
Dry matter in fæces	799	
Ditto milk	57	
Ditto urine	103	
Ditto silage, brewery grain, etc.	643	
	<hr/>	1,602
Single nitrogen determinations :—		
Fresh fæces	172	
Urine	312	
Milk	57	
	<hr/>	541
Mineral analyses—foods, fæces and urine	229	
Complete analyses of urine	102	
	<hr/>	
TOTAL	2,620	
	<hr/>	

IV. ENQUIRIES INITIATED DURING 1925-26.

The work carried out during the first year was confined to a study of the food-stuffs used in the dairy. While these experiments were in progress, plans for systematic enquiries were prepared. The lines of work which have been adopted for the present are described below under the following heads.

(a) *Experiments on the nutrition of growing animals.* The work with young stock is important for three reasons. Considering first the animals themselves, they are delicate and have not developed their digestive systems. Their rations have to be carefully considered. Secondly, from an economic point of view, the feeding of unsuitable food to calves results

in serious loss. Thirdly, the demands of the growing animal are rigorous, and hence the shortcomings of a food are likely to be decisively indicated by young stock. For these reasons the Nutrition Section is constantly increasing its work on young animals.

An interesting experiment with calves was concluded four months ago at Bangalore. The animals were divided into three groups receiving different types of concentrates which contained respectively A 13·9 per cent., B 26·9 per cent., C 30·3 per cent. protein. The quantities fed were so selected that the net energy provided by the concentrates A and B were equal, whilst the protein content of B was much higher. Ration C provided more protein but less net energy than ration A. Roughage was given *ad lib.* The amounts of concentrates fed and the growth obtained are shown in the accompanying table.

TABLE I.

Showing amounts of concentrate given and live-weight increases obtained.

— —	Ration A	Ration B	Ration C
Total concentrate (lb.) fed per 1,000 lb. live weight.	21·30	16·00	10·70
Protein (lb.) supplied in concentrate per 1,000 lb. live weight.	2·97	4·31	3·25
Net energy (therms) supplied in concentrate per 1,000 lb. live weight.	11·49	11·49	10·70
Average daily increase (lb.) per 1,000 lb. live weight.	5·72	5·43	4·39

The figures show that with these rations growth is not proportionate to the protein but runs more nearly parallel to the net energy of the concentrate. The fate of the food protein

is shown in the following data obtained from a nitrogen balance experiment with six of the calves.

TABLE II.

Showing nitrogen balance experiment with six calves.

Grm. per day	RATION A		RATION B		RATION C	
	Calf 1	Calf 2	Calf 3	Calf 4	Calf 5	Calf 6
Total protein nitrogen in ration	53.42	56.50	95.05	68.69	78.14	55.77
Nitrogen digested	32.88	34.22	67.33	49.36	51.84	36.01
Nitrogen excreted in urine .	14.23	13.36	48.66	30.31	35.90	24.02
Nitrogen retained for flesh formation.	18.65	20.86	18.67	19.05	15.94	11.99

In ration A the amount of nitrogen digested is low, but excretory losses are also very low and hence the balance retained is satisfactory. In ration C the amount of nitrogen digested per 1,000 lb. live weight is much higher, but the retention is less perfect.

In these experiments, as already stated, roughage was provided *ad lib*, but the actual amount consumed daily by each animal was accurately determined. The roughage consumption together with other significant figures is given in the accompanying table.

TABLE III.

Showing average daily consumption of dry matter in lb. per 1,000 lb. live weight.

	Average live weight in lb.	Daily increase per 1,000 lb. live weight in lb.	FOOD CONSUMED PER 1,000 LB. LIVE WEIGHT			Amount of roughage to 1 of concentrate	% Digestion of ration
			Roughage	Concentrate	Total		
A ration . .	218	5.72	10.83	16.25	27.08	0.781	59.8
B ration . .	217	5.43	13.02	13.06	26.08	1.130	60.6
C ration . .	207	4.39	14.84	8.68	23.52	1.899	60.0

This table contains important information. The figures show in the first place, as was to be expected, that a high allowance of

concentrate is accompanied by low consumption of roughage and *vice versa*, that the highest total consumption occurs when concentrate is high and that the live weight increases run parallel with the total consumption. The last fact is especially significant. It appears that the total amount of organic matter digested and the percentage digestion are very important measures of the actual value of a ration, and that the proportion of protein may vary within wide limits without influencing the rate of growth. The actual quantities of food consumed and growth obtained in this experiment are expected to be valuable guides to the practical dairy cattle feeder in this country. The results in such feeding tests, however, depend very much upon the nature of the roughages employed. More experiments on these and similar lines are required to determine suitable concentrate allowances for the various roughages.

(b) *Indian coarse fodders.* Under this head it is intended to carry out a systematic study of the chief Indian roughages. We possess a certain amount of information concerning our concentrates. We can assign fairly definite food values to very many of them. With the Indian roughages the situation is altogether different. We do not know the elementary facts regarding their digestibility, energy value or other characteristics. Further, as the roughage forms the bulk of the ration malnutrition and nutritional diseases almost invariably arise from deficiencies in the roughage. The enquiry on coarse fodders is, therefore, an urgent matter.

The first series of tests was made with rice straw and Indian baled hay. The experiment came to an end recently and has yielded most interesting information. Accurate digestion data have been procured, and the net energy values of the two roughages have been determined indirectly. It was found that our rice straw has a decidedly higher net energy value than that assigned to the American product. The hay was inferior to average American hay. These figures will be of the greatest use for rationing purposes, and in fact the Military Dairy Farm Department has specifically asked the Nutrition Section for information which these figures provide.

The information gleaned from this experiment does not end here. In the course of the work a remarkable physiological effect due to rice straw was discovered. It was found that rice straw produces persistent diuresis, and the cause of this diuresis was traced to the high potash content of the straw. The animal is obliged to get rid of the excessive intake of this base. The figures in the following table taken from a paper recently submitted for publication by the Nutrition Section brings out these facts clearly.

TABLE IV.

Showing average excretion of urine and potash by animals fed on rice straw and hay respectively.

		1,000 LB. ANIMALS		750 LB. ANIMALS		500 LB. ANIMALS.	
		No. 1 Straw	No. 2. Hay	No. 1 Straw	No. 2. Hay	No. 1 Straw	No. 2 Hay
Average daily urine excretion in kilos	1st test, April, 1925 .	7.871	3.947	7.797	3.665	6.299	3.219
	2nd test, Sept., 1925 .	6.830	2.842	5.877	3.021	4.968	3.141
	3rd test, Nov., 1925 .	7.572	3.329	7.223	3.338	5.745	2.563
	Average	7.091	3.373	6.966	3.341	5.671	2.974
Average daily potash excretion in grm.	1st test, April, 1925 .	92.50	33.14	83.77	27.11	61.43	20.14
	2nd test, Sept., 1925 .	100.30	31.50	92.20	26.30	67.13	21.52
	3rd test, Nov., 1925 .	130.58	33.50	119.53	31.27	90.07	22.21
	Average	107.79	32.71	98.50	28.23	72.88	21.29

It is impossible to say, at present, what the effect of this diuresis will be. Up to a point the elimination of urine is a healthy symptom. It may be expected to clear the system. On the other hand, the excretion of very large amounts of urine, or of urine of abnormal reaction, is a strain on the kidneys and must inevitably lead to serious results. It is possible that a subject of fundamental importance to animal nutrition in India has been met with here. The question is being followed up tentatively at present.

The systematic examination of Indian roughages is proceeding. A second series of tests, on a somewhat larger scale, with more bullocks and intended to deal with four new roughages has been commenced. The intention in this work is to add steadily to its utility and scientific significance by increasing the number and nature of the observations made during the long period of feeding. Some clinical tests will be introduced this year and eventually it is intended to do respiration experiments with these animals.

(c) *Mineral requirements.* Recent work in Europe has shown that the productive capacity of an otherwise sufficient ration may be completely lost through inadequacy of the mineral supply, and conversely it has been found that the addition of appropriate minerals in such cases greatly enhances the productive capacity of the food. It is impossible to lay too much stress on this question in India. Mineral shortage is common, and it must lead to a waste of the potential nutritive power of the organic matter produced by plant growth. Experiments on mineral supplements required for growing stock have been commenced at Bangalore. The test with calves, mentioned above, was used mainly to decide on suitable rations for this purpose. A comparative test was, however, carried out concurrently, a check lot being fed on the same rations, but without a mineral supplement. There was a marked and consistent difference between the controls and the lime fed lot in favour of lime feeding, but stress is not laid on this preliminary result at present. Appropriate rations having been fixed, a more extensive experiment focussed solely on the mineral question has been started. The subject of mineral supplements was, however, deemed of such importance that efforts were made to amplify the work at Bangalore by using outside resources. For this purpose, preliminary experiments have been carried through at Hosur (the Central Cattle Breeding Station of the Madras Department of Agriculture), and plans are ready for a trial there during the coming season. A somewhat different experiment relating to the same subject has been proposed to the Military Dairy Farms. The proposal

has been accepted, and work will commence as soon as this Section can spare the necessary staff.

In the preliminary experiment at Hosur mineral tests were not attempted. A simple feeding experiment to compare hay and grass silage was carried out in order to study the conditions of work there. Thanks to the facilities given to this Section by Mr. R. W. Littlewood, Deputy Director of Agriculture, Live Stock, Madras, the effort has been an unqualified success. The results obtained in the first Hosur experiment, though they do not deal directly with the mineral question, deserve notice. Sixteen animals were selected for the experiment. They were carefully paired and divided into two groups. The one group was given hay, the other silage. A weighed excess of roughage was fed to each animal and the residue left by each was weighed daily. Both groups received the same amount of concentrate, namely, one pound cake and two pounds rice bran per head. The animals themselves were weighed daily during the entire experimental period which lasted 13 weeks. The main results obtained can be shown in a condensed form. The following figures give the changes in live weight which took place during the feeding period—

	Silage group	Hay group
Final average live weight per head lb.	514	471
Initial average live weight per head lb.	485	474
Average increase per head lb.	+ 29	—3

There can be no doubt that the silage was more effective than the hay. To give force to these figures it should be observed that the average live weight per head is taken from the weekly average live weights of 8 animals. Each figure in the table is, therefore, derived from 56 live weight determinations. The first impression from these figures is that silage is far more nutritious than hay. This is not the case. The silage and

hay are probably about equally nutritious. The difference in effect is entirely accounted for by the quantities consumed. The average consumption of dry matter from roughage per head per day was found to be—

	lb.
For the silage group	8.363
For the hay group	5.860

These are striking and important figures. This experiment has yielded much valuable information. It has shown in the first place that a productive ration cannot be obtained from spear grass hay. The animals consume just enough to maintain themselves. In the second place, it has shown the advantage of converting spear grass into silage. The silage is probably not more nutritious, but it is consumed more readily and in amounts above the maintenance requirement. Hence it becomes a productive ration. The hay fed for 13 weeks—together with concentrate be it noted—gave no return whatever. The economics of cattle rearing are well illustrated by these figures. The experiment has also yielded material from which the nutritive values of the roughages can be determined. The necessary analyses for this purpose, however, have not been completed yet.

To be fair to the work of this Section, the figures for average dry matter consumption per head given above must be referred to once more. They are the figures that have elucidated the real meaning of silage efficiency in this particular case. These two figures for dry matter consumption are the result of an enormous amount of work. Not only was the ration and residue of each animal determined daily for a period of 13 weeks, but the daily variations in moisture content of the hay and silage had to be allowed for and in addition to this the partial drying up of the silage while it lay in the trough had to be taken into account daily. To carry out a test of this kind entails labour and demands a great deal of organization. It is work which can only be done by trained men and a trained staff. In this case, too, it was done at an outstation and not at head-

quarters. The Section should have more men for dealing with work of this kind.

(d) *Indian pasture grasses.* This work follows along the lines of the most recent observations upon pasture land which have been made in England. Here again the Section has been fortunate in finding outside support. A large amount of work; including analyses, digestion experiments and long period feeding tests, is in progress at Bangalore on material supplied by the Military Grass Farms. The Bombay Department of Agriculture has taken a great deal of interest in its pasture problem for many years past. The Nutrition Section, having approached the Bombay Department, is to be provided very shortly with most valuable material from this part of the country. Finally on the strength of the Hosur feeding experiments, already referred to, the Director of Agriculture, Madras, has agreed to the necessity for laying down new grass at Hosur. This is a most important experiment which will eventually provide further material for crucial tests by the Nutrition Section.

The work outlined above aims mainly at a determination of the variations in quality which are to be expected. The next step must be attempts to obtain higher productivity from definite areas which the present experiments are expected to locate for us. This work will involve careful feeding experiments carried out on the spot. The Nutrition Section must have the staff and organization ready for this approaching task.

(e) *Karnal feeding experiments.* The first experiment carried out at Karnal was designed to test the value of different local coarse fodders for winter rationing of calves. The calves were divided into four lots receiving respectively *dhub* (*Cynodon dactylon*) hay, rice straw, sorghum straw and wheat straw, *ad lib.* Concentrate was given in equal amounts to all the animals. Live weights were determined daily and the quantity of roughage consumed by each calf was also determined every day. The results obtained in this long period test covering 120 days are given in a highly condensed form in the accompanying table.

TABLE V.

Ration	Average live weight per head	Average live weight increase per head	Average daily roughage consumed.
	lb.	lb.	lb.
Hay	301	0.31	5.58
Rice straw	297	0.61	6.96
Sorghum straw	300	0.57	5.74
Wheat straw	297	0.41	5.44

It should be observed that each live weight figure is the average of 42 weighings of five animals. Each figure for live weight increase is the average difference between two sets of 21 weighings of five animals. The roughage consumption was determined for each animal for 120 days. The figures show that rice straw was most greedily consumed and gave the highest live weight increase. This result is contrary to local opinion which holds that wheat straw is preferable, and the preference is so strong that the local price of wheat straw is four times that of rice straw. A fact of considerable economic significance has been arrived at here. The sorghum may have been somewhat too tough for such young animals and might conceivably show much better results with older stock. The hay result is certainly remarkable. That rice straw should give better results than *dhub* hay which is believed to be one of the most nutritious grasses in India, is a matter deserving attention. Further experiments are being planned for Karnal.

V. TRAINING OF POST-GRADUATE STUDENTS.

The training of post-graduate students has been continued on the lines laid down two years ago. Two students passed through the course last year. One student is undergoing training and another student is waiting to come. He will be taken in when the present building operations have been completed.

VI. ASSISTANCE GIVEN BY THE NUTRITION SECTION TO THE SECTION OF THE IMPERIAL DAIRY EXPERT.

1. Courses of lectures on Chemistry (by an Assistant in the Nutrition Section) and on Animal Nutrition (by the Physiological Chemist personally) were provided for the Dairy Diploma students.

2. The Imperial Dairy Expert asked for a practical procedure for accurate cream neutralization in connection with pasteurization. The Nutrition Section carried out an investigation of the question. A practical process was evolved and handed over to the dairy in a workable form.

3. A question relating to cheese-making has recently been submitted to this Section. At present preliminary enquiries are being made.

I would like to record here my deep appreciation of the whole-hearted support which the Imperial Dairy Expert has invariably given to this Section, and often it has been given at considerable inconvenience to himself.

VII. CO-OPERATION WITH OTHER DEPARTMENTS.

The following is a list of the experiments which have been undertaken during the past year in co-operation with other departments.

1. *Madras Department of Agriculture.*

(a) Feeding experiments at Hosur. The cattle, the foods and the accommodation were provided by the Madras Department. The work, including a long period quantitative feeding test, a digestion experiment and analysis, was done by the Nutrition Section.

(b) Grass experiments at Hosur. The necessity for this work was urged by the Nutrition Section. The first part will be carried out by the Madras Department. The Nutrition Section will institute tests at a later stage.

2. *Bombay Department of Agriculture.*

- (a) The Nutrition Section proposed an examination of grazing area herbage. The Bombay Department Committee on Pasture Problems readily agreed to co-operate in this work.
- (b) Requests have been made by the Joint Director, Bombay, to the Nutrition Section to carry out certain feeding tests. The Section unfortunately could not undertake the tests this year owing to shortage of staff and very great pressure of other work. It is hoped to meet the wishes of the Bombay Department next year in this matter.

3. *Military Grass Farms and Military Dairy Farms.*

- (a) Examination of Indian hay. The work includes analyses of types, digestion trials with types and long period feeding tests with types. The Nutrition Section carries out all the work at Bangalore. The material is supplied free of charge by the Military Grass Farms. I must acknowledge the zeal with which the Military Grass Farms have taken up the enquiry. Every question is promptly and fully considered; every request is immediately met.
- (b) Feeding experiment at Belgaum. This work has been mapped out and preparations for it are under way.

4. *Imperial Cattle Breeding Farm, Karnal.* The experiments designed by the Nutrition Section for Karnal were ably carried out by the Superintendent of the farm. The digestion experiments and the analytical work were done by the Nutrition Section. The Nutrition Section is very greatly indebted to the Agricultural Adviser, Dr. Clouston, for the financial assistance which he gave for this work.

VIII. PUBLICATIONS.

The work of publication has just commenced. The results of the first year's experiments (1924) have been embodied in two Memoirs already published. The completed experi-

ments of 1925-26 will form four Memoirs, but the writing of this work is only half done. The subjects dealt with are :—

1. Nutrients required for milk production with Indian foodstuffs. (*Mem. Dept. Agri. India, Chem. Ser., VIII, No. 7.*)
2. Nutrients required for growth production with Indian Foodstuffs. (*Mem. Dept. Agri. India, Chem. Ser., VIII, No. 11.*)
3. Bangalore maintenance experiments, 1st Series. (*Mem. Dept. Agri. India, Chem. Ser., IX, No. 2.*)
4. Calf feeding experiments at Bangalore in 1925.
5. The relative feeding values of hay and grass silage, Hosur Experiments, 1925-26.
6. Roughages for winter feeding of young stock in the Punjab, Karnal Experiments, 1925-26.

The following articles have been submitted for publication in the "Agricultural Journal of India":—

1. The application of feeding standards to dairy cattle in India. (*Agri. Jour. India, XX, Pt. 6.*)
2. Factors influencing the cost of food for milk production. (*Agri. Jour. India, XXI, Pt. 1.*)
3. The relationship between digestibility and net energy values. (*Agri. Jour. India, XXI, Pt. 6.*)

IX. PROGRAMME OF WORK FOR 1926-27.

Major subjects.

1. Experiments on the nutrition of growing animals. This work involves tests at Bangalore and Karnal.

2. A study of Indian coarse fodders, including determinations of maintenance rations and studies of nitrogen and mineral metabolism. This is a continuation of the systematic work commenced during the past year at Bangalore.

3. Mineral requirements of young stock. Experiments at Bangalore, Hosur and Belgaum are contemplated.

4. Examination of Indian pasture grasses. This work will be carried out in co-operation with the Military Dairy Farms and the Bombay and Madras Departments of Agriculture.

5. Experiments on milk production. It is intended to take up this subject again before the end of the year.

Minor subjects.

1. A study of the chemical methods employed in the above enquiries.

2. Preliminary experiments for the initiation of work on other aspects of nutrition.

Training.

1. The training of post-graduate students, which is an important branch of the work of this Section, will be continued as usual.

2. For the Dairy Diploma students a course in general science, plant chemistry, nutrition and dairy chemistry, will be provided by this Section.

REPORT OF THE GOVERNMENT SUGARCANE EXPERT.

(RAO SAHEB T. S. VENKATRAMAN, B.A.)

I. CHARGE AND STAFF.

I was in charge of the office of Government Sugarcane Expert for the whole year. The Second Cane-Breeding Officer, Mr. Nand Lal Dutt, M.Sc., joined duties on 3rd April, 1926. The Assistant Sugarcane Expert was in immediate charge of the bulk of the routine work including accounts.

II. RESEARCH AND INVESTIGATIONS.

(a) *Technique of breeding.* An appreciable advance in the technique of cane breeding was effected during the year, by the successful isolation of live cane arrows away from the reach of unintended pollen.

During the flowering season the arrows in the field are generally surrounded by an atmosphere heavily laden with the pollen of the different varieties in flower at the time. Emasculation and bagging are both unavailable for sugarcane breeding on account of their adverse effect on the arrows, and, in the absence of these safeguards, considerable doubt often arises as to the actual parentage of a batch of artificially pollinated seedlings. It had been realized for some time that one method for securing greater certainty would be the segregation of the arrows, in places where unintended pollen could not get access to them. Previous attempts in this direction had proved failures on account of the methods employed being either cumbersome or inefficient.

The knowledge of rooting in canes—obtained from the root studies by the writer in recent years—enabled the development of a satisfactory method during the year. The method consists in artificially inducing a fresh set of roots on the cane, whose arrow it is desired to segregate (some time before the emergence of the arrow from the enclosing leaf-sheath), and

subsequently transferring the treated cane to the desired locality. Thus treated the arrow develops in a normal manner and lends itself to the subsequent operations.

Some time previous to the working out of this method at Coimbatore, a very valuable method had been evolved at Hawaii, by which cane arrows could be kept developing and yielding viable pollen all through their development by keeping the lower joints in a dilute solution of SO_2 . The Coimbatore method would appear to possess certain advantages, the most important of them being a higher percentage of germination in the resulting seeds.

(b) *Control of male fertility in sugarcane arrows.* The experiments detailed last year were continued, a larger number of solutions being employed in the artificial feeding of the arrows. The solutions tried included among others the following in varying strengths : potassium permanganate, aspirin, formaline, mercuric chloride, aluminium chloride, iodine, dextrose and bismuth iodide. The arrows, during their development, were further subjected to low temperature conditions ; this was based on the known infertility of pollen in North India, low temperature being one of the environmental factors. No definite success can yet be claimed for the above methods. For final success it would appear necessary to determine, first, the exact time when the pollen grains begin to form and, second, the exact strength of solution that would inhibit the formation of healthy pollen without, at the same time, adversely affecting the other vital organs of the flower.

(c) *Set versus shoot roots.* In recent years investigations have been carried on elsewhere on the relative functions of seminal as contrasted with nodal roots in cereals. In a sense the sett roots of the cane plant correspond to the seminal and the shoot roots to the nodal roots of cereals. Definite indications had been obtained in the past about a certain relationship between the growth and development of the two classes of roots and the vegetative growth of the young plant. In the ordinary method of cane germination the two classes of roots soon get intermingled with each other and studies on their relative functions had, in the past, been handicapped

through the absence of a method, by which the growing cane could be made to depend, at a time, entirely on the one or the other class of roots.

During the year a method was successfully developed by the Botany Assistant R. Thomas. In this method two budded sets are planted vertically in pots, instead of horizontally (the usual practice), one of the nodes being placed above ground and the second under it; the root zones or the dormant buds are removed according to the needs of the experiment. The method renders it possible to throw the developing plant entirely on either class of roots. By this method the young plant could further be made to develop and grow at some height from the soil away from its roots; such a position facilitates continuous observations being made on the habit and tillering of the plant.

(d) *Repetition of useful lines.* The seedling Co. 205 has shown remarkable properties under cultivation in the Punjab and the United Provinces. This seedling, which is a hybrid between Vellai and *Saccharum spontaneum*, has two defects, viz., late maturity and impure juice. During the year a large number of seedlings of the same parentage as Co. 205 were raised, in the hope that some of them might show the good characters of Co. 205 with the defects either absent or present in a lesser degree. Vellai is rather uncertain in seed fertility; and the cross-pollinations had to be done on as many as 300 arrows located in nine different places. One thousand three hundred seedlings have been obtained and are so far satisfactory in vigour of growth. Besides the above, about 20,000 plants of the F_3 generation were raised, and 4,000 of these are now in the nurseries for a further selection. Repetition of useful lines, either to replace seedlings if they happen to deteriorate, or to improve upon current seedlings, would be one definite line of future work at the station.

(e) *Inheritance studies.* There are various difficulties associated with the study of inheritance in the sugarcane. Though the data and available material are not of the same nature as are now available for other crops, the indications of inheritance that have been obtained have been of practical use in

working to a desired type. A deeper rooting, for instance, has often been secured by cross-pollination with either *Saccharum spontaneum* or Co. 205; a higher sucrose in juice has often been obtained by the use as parents of Co. 214, P. O. J. 2690 and P. O. J. 2725. In the breeding of canes for tropical India, hybrids between the later P. O. J. canes and the more promising of the Coimbatore seedlings bred for Northern India would appear to offer a promising line of advance.

(f) *Morphological descriptions.* With the increasing spread into cultivation of the Coimbatore canes a need has arisen for short morphological descriptions of these with the definite object of identification. An attempt is being made to add to the existing list of characters, with the object of discovering more differences among seedlings which are rather similar in appearance. The Second Cane-Breeding Officer is working out the application to the Coimbatore seedlings of Dr. Jesweit's method of identification based on hair groups in the buds.

(g) *Vitality of weed seeds.* In the plots at the station it is obviously desirable to keep out weeds altogether. The commonest of them, *Trianthema monogyna*, L. has been under study for four years. It has been found (1) that the above seeds need a period of rest for proper germination, (2) that they do not all germinate together even when uniform and satisfactory conditions are available, and (3) that the seeds keep their vitality for as long a period as four years. In the earlier stages of growth, the plants are easily killed by a liberal spray with a dilute solution of tar emulsion; this preparation, besides killing the weeds, also keeps out white ants, thus serving a dual purpose.

III. PERFORMANCE OF COIMBATORE CANES IN OUT STATIONS.

One or other of the Coimbatore canes has now obtained a firm footing in every sugarcane growing province in North India from the Punjab to Bengal. A valued correspondent from Bihar has recently written that "in the area east of the Gundak, Hemja is fast going out and nearly all the European planters will plant nothing but Coimbatore canes this year." In the 1923-24 annual report of the Department of Agriculture,

Bengal, the Deputy Director of Agriculture, Dacca, states that "Co. 213 beats all others."

Besides the seedlings which have already gained some repute in North India, others are coming into favour; such are Co. 219 in the Central Provinces, Co. 223 in the Punjab and Co. 204 in the Western Circle of the United Provinces. A favourable report as to the vigour of growth of Co. 281 has been received from Cuba.

IV. THE MONEY VALUE OF THE COIMBATORE WORK.

It is a matter of common experience that improved varieties take some time to spread and their progress into cultivation is comparatively slow during the first few years. It is now about four years since the Coimbatore canes came into general cultivation. Even so, the increased profit from the cultivation of the Coimbatore canes in place of the local varieties, was computed last year at one and a quarter lakh of rupees in Bihar and at about a third of a lakh in one Circle of the United Provinces.

When last I was in Bihar, I understood that the area this year might be four-fold of what it was last year. It will thus be seen that the net money value of the work will rapidly increase, as the new seedlings spread into cultivation.

V. RECEIPT AND DESPATCH OF CANES.

Only one cane variety was imported from abroad during the year, *viz.*, Natal Uba, through the Sugarcane Research Station at Shahjahanpur. During the year 13 fresh seedlings were added to the number of seedlings already sent out for trial; and these have been sent to Pusa in the first instance. Six seedlings were despatched to a correspondent in Portuguese East Africa on request.

Though no elaborate work has been in progress at the station for breeding the thick type of cane, yet some thickish seedlings obtained in the breeding of the North Indian types as also certain thick seedlings raised in recent years, were available for planting in the new area recently acquired for doing work on the thick class of canes. Certain thick varieties

imported from overseas in previous years were also distributed to Pusa, Dacca and to two places in South India for trial.

During July last year very suspicious markings, similar to mosaic, were noticed by the writer at the Central Farm wet lands, situate about a furlong to the south-east of the station. This was brought to the notice of the Government Mycologist at Coimbatore, and a high degree of infection with mosaic in these fields has since been recorded. The station was able to supply to the Central Farm at Coimbatore and to two parties in the district of South Arcot in the Madras Presidency mosaic-free material of certain canes. In February 1926 the sugarcanes at the station were kindly examined by the Imperial Mycologist from Pusa. Two canes which showed suspicious markings were isolated ; these have since been identified to be mosaic infected by the Imperial Mycologist.

VI. THE FARM.

The area at the station was increased by the acquisition of 38.54 acres, the bulk of the new area being intended for breeding the thick type of cane. This new area was handed over on 12th of March, 1926 ; and, within a couple of months, the first cane crop on this land consisting of over 120 varieties and seedlings was planted. The laying out of the area into suitable blocks for cane cultivation has been taken up.

The old area at the station was suffering from an inadequate supply of water for cane, all cane crops being dependent on the only good water well in the area. An alternative site for a second well has been selected after nine trial borings and analysing the waters obtained. This second well, when completed, would enable a fuller utilization of the available area for cane growing, besides supplying water to the residential buildings now under construction. Two of the old wells whose waters were too brackish for cane irrigation are being filled up with earth obtained from the foundation excavations of the new buildings.

The *senji* (*Melilotus parviflora*) crop of North India was tried for two seasons but had to be dropped as unsuitable. During the year over 3,000 plots were planted with cane,

the bulk of them with Coimbatore seedlings in different stages of selection.

The receipts during the year amounted to Rs. 3,928 ; of this amount Rs. 350 represents collections as house rent.

VII. PUBLICATIONS.

The publications from the station during the year include :—

- (1) “ Studies in Sugarcane Germination,” by Rao Saheb T. S. Venkatraman (*Agr. Jour. India*, XXI, pp. 101-106).
- (2) “ Sugarcane-breeding technique—Isolation of live arrows from undesired pollen through artificial rooting of canes,” by Rao Saheb T. S. Venkatraman and R. Thomas (*Agr. Jour. India*, XXI, pp. 203-209).

The former has been reproduced in full with illustrations in more than one Foreign Journal.

VIII. PROGRAMME OF WORK FOR 1926-27.

Major.

The breeding of canes will be continued with the object of securing further improvements or covering new tracts.

Further improvements will be attempted in the breeding technique, as such improvements have a direct influence both on the quantity of work done and the rapidity of results obtained.

Minor.

Study of root development in sugarcane varieties and of the factors influencing cane germination will be continued, as time becomes available, and based on the results obtained during the current year.

Morphological descriptions of Coimbatore seedlings will be attempted with a view to facilitate their easy identification in the field.

REPORT OF THE SECRETARY, SUGAR BUREAU.

(RAO SAHEB KASANJI D. NAIK, M.A.)

Mr. Wynne Sayer held charge of the office of Secretary, Sugar Bureau, up to 24th March, 1926, when he proceeded Home on 6½ months' leave, and I was appointed to carry on the current duties of the post in addition to mine own as Superintendent. In the subordinate staff the only change that took place was the transfer of the two posts of Fieldmen to the Agricultural Section of the Pusa Institute with effect from 1st April, 1926, as all agricultural operations in connection with the growing and testing of canes at Pusa will in future be carried out by that Section in consultation with the Secretary, Sugar Bureau. The Government of India's sanction to the further retention of the Sugar Bureau up to 31st March, 1927, was received during the year.

During the year under report the Bureau continued to collect information relating to the sugar industry in India and abroad and to make it available to the public. It has already got a mass of valuable information which is being freely availed of and highly appreciated by those in the sugar line.

I. AGRICULTURAL.

The Bureau also carried on its agricultural activities which consisted mostly in (1) importing selected varieties from abroad and growing them under observation, and (2) testing the new Coimbatore seedling canes for their suitability to North Indian conditions.

A very large and important firm in Madras, who are interested in improved thick cane cultivation in the Southern Presidency, reported that Fiji B (which is the same as Badila) was showing signs of deterioration and it was advisable to import fresh healthy stock. The Secretary, Sugar Bureau, accordingly arranged to import during the year sets of Badila from Frinidad, where there is no Fiji disease, direct importation

from Australia having been prohibited by the Government of India Destructive Insects and Pests Act as revised in 1922.

Another cane imported was D. 625 from the Director,* Department of Science and Agriculture, British Guiana. The body colour of this variety is bright yellow, blotched with crimson and with a red ring round the cane just above each node. This cane is reported to be extraordinarily vigorous in growth in British Guiana and to do best on deeply cultivated, medium to heavy clay soils. It has also been found to be fairly resistant to the effects of drought and to be little or very slightly affected by root and rind diseases.

Four Java seedlings, viz., P. O. J. 2714, 2725, 2727, and 2878 were received from the well-known Sugar Experiment Station, Pasoeroean, East Java. It may be mentioned here that these seedlings are reported to be immune to mosaic and also to give high yields and hence are of great potential value for cross-breeding work in India.

These canes were on arrival examined by the entomological and mycological experts and then planted under strict quarantine conditions. Unfortunately, all of them died one by one and hence a fresh importation will be necessary.

B. H. 10 (12), a Barbados seedling which has been doing so well in the West Indies and which is a rich variety with high sucrose content, has been obtained from Coimbatore this February and is being tried in the experiment plot.

A few sets of the thick cane, Assami Red, were obtained from Peshawar in the planting season 1925 and grown in the experiment plot with a view to find out whether this cane, which is such a success in the North-West Frontier Province, would do equally well in the white sugar tract. It

* The following extract from the late Sir J. B. Harrison's letter to the Secretary, Sugar Bureau, will be read with interest :—

“Very large numbers of seedlings of D. 625 have been raised here, but although many of them show a very marked improvement on the parent cane in sugar content none have approached it in its vigour of growth.

“A very careful mathematical investigation of the characters of these new seedlings has led us to believe that D. 625 is a cane of almost to quite pure parentage. Unlike the great majority of large sized tropical canes, D. 625 produces seed almost altogether true to type. It may thus be of some use to you in your cross-fertilization experiments.”

did fairly well under irrigation but was heavily attacked by the top shoot borer. Selected sets of this variety have been planted again to see whether it will be possible to grow this cane as an unirrigated crop. The present indications are unfavourable.

Coimbatore seedlings. The following seedlings were planted again as they were found promising in 1924-25. This year they were grown in small plots but without any irrigation :— Co. 248, 250, 270, 273, 281, 282, 286, 287, 288, and 290 against the standard cane Co. 213.

Co. 248 is a medium thick cane with erect habit and fairly good growth but it does not tiller well. It is susceptible to mosaic. Co. 250 is also susceptible to mosaic. Co. 270 tillers well. No mosaic was observed on it during the year. It will therefore be grown on to test its yield per acre, drought resistance, etc. Co. 273 is erect in habit with good growth. Its tillering is good. No case of mosaic has yet been observed in this variety. Though it is found to suffer from the late start of the monsoon, it looks a good tonnage cane and will be grown on a larger scale for mill trial.

Co. 281 has erect habit and is a vigorous grower especially in the beginning. It is a medium thick cane with long internodes and tillers well. But there is considerable splitting of the canes. It is affected by mosaic and much damage is caused by root borers.

Co. 282 is also attacked by mosaic. It is, however, not so bad as Co. 281 and so will be given a further trial.

Co. 286 has been rejected. It is late in germination, has short joints, and its tillering capacity is not as good as that of other seedlings. It was heavily infected by top shoot borers and also showed considerable splitting, besides being susceptible to mosaic.

Co. 287, a vigorous grower with good tillering, stands the hot weather well but is heavily attacked by mosaic.

Co. 288 germinates early. It is a medium thick cane with fair growth and good tillering. It is liable to mosaic.

Co. 290 is the most promising variety at present. It is a medium thick cane which tillers well and makes vigorous growth. It has stood the prolonged drought very well and has so far not been affected by mosaic. It will be grown on a large scale for mill trial.

Another batch of new seedlings was received from the Coimbatore Cane Breeding Station in February 1926, and these have been planted for purposes of testing. The seedlings are being grown under irrigation this year and will be multiplied by short-planting in July. They have been planted close to a mosaic experiment plot with a view to test their susceptibility to this disease. Some of these new arrivals are crosses between Co. 213 and Co. 214 which have been found so successful in North Bihar. All of them have a good sucrose content as evidenced by the analytical figures supplied from Coimbatore, and they are also reported to have good vegetative characters.

The parentage of the new seedlings is given below :—

Co. 294	.	.	.	P. O. J. 213 × Co. 229.
Co. 295	.	.	.	Co. 213 × Co. 214.
Co. 296	.	.	.	Co. 213 × Co. 214.
Co. 297	.	.	.	Co. 213 × Co. 214.
Co. 298	.	.	.	Co. 213 × Co. 214.
Co. 299	.	.	.	Co. 213 × P. O. J. 1410.
Co. 300	.	.	.	Co. 213 × P. O. J. 1410.
Co. 301	.	.	.	Co. 213 × P. O. J. 1499.
Co. 302	.	.	.	Co. 213 (general collection).
Co. 303	.	.	.	Co. 221 × P. O. J. 1507.
Co. 304	.	.	.	P. O. J. 1547 × Co. 229.
Co. 305	.	.	.	Kaludai Boothan × P. O. J. 2696.
Co. 306	.	.	.	Kaludai Boothan × P. O. J. 2696.

Observations at Pusa so far show that most of these seedlings are vigorous growers with good tillering powers. Of these, Nos. 297, 298, 300 and 305 are medium thick and if they continue to do as well as they promise at present, they will prove suitable for the white sugar tract in North India.

Co. 275, a medium thick cane with good even germination leaving few blanks in the rows, with good tillering and erect

habit, planted as a field crop under unirrigated conditions was found quite satisfactory, and its yield was at the rate of 600 maunds per acre. It is not, however, immune to mosaic. Co. 280 was also grown on a field scale but its yield was very much poorer than that of Co. 275, as its tillering is not so good and the germination is very gappy. No cases of mosaic were observed on this cane during the year under report. Both Co. 275 and 280 are being tried again in 1926-27.

Co. 205 was grown on an estate scale and its yield was over 600 maunds per acre. An analysis of this variety was arranged at the Samastipur sugar factory on 1st February, 1926. The cane was crushed in a three-roller hand mill and gave the following results :—

Juice	{ Brix	20.18
	{ Sucrose	16.68
	{ Purity	82.66
Cane	{ Fibre per cent.	19.57
	{ Solids per cent.	16.23
	{ Sucrose per cent.	13.42

As this variety will grow on poor lands and with indifferent treatment, and can stand the two opposite extremes of drought as well as water-logging, it is being multiplied for seed distribution.

Manurial and other experiments. At the suggestion of the Chilean Nitrate Committee (Indian Delegation), Calcutta, two experiments have been laid down—(1) to test whether 1 cwt. of NaNO_3 and $1\frac{1}{2}$ cwt. of concentrated superphosphate applied to cane at the time of planting in October, followed by a dressing of NaNO_3 at the rate of 1 cwt. per acre at the break of the rains, will tend to make the unirrigated cane crop outgrow the moisture available in the soil at the time of planting in October; (2) to test the efficacy of a special proprietary complete cane fertilizer, applied alone at the rate of 3 cwt. per acre at planting time in February to a crop to be grown without irrigation, with the usual dressing of Nitrate of Soda given at the break of the rains. The area treated is one acre. At harvest the yield of this acre plot will be compared with

the outturn from an acre of land treated with one ton of mustard-cake at planting time but with no further dressing of a nitrogenous fertilizer at the break of the rains. This experiment will be continued next year and for another year if necessary.

The Produce and Chemical Co., Ltd., London, wrote to the Secretary, Sugar Bureau, in November 1925, that they had a phosphatic fertilizer, called sulfurophosphate, and it was reported that sugar-beet treated with this fertilizer in France gave an increased yield of 10 kilos sugar per ton on the beet treated in the ordinary way with superphosphate. Another feature mentioned was that it did not contain any free acid and consequently there was no burning of bags in transit. Again, it was claimed that it was more suitable for storing than super and could remain indefinitely in a fine powdery form. Its price also compared favourably with super—the grade of sulfurophosphate with 25 per cent. phosphoric acid equivalent to 54 per cent. phosphate of lime, costing £4-11-3 only per ton of 1015 kilos, packed in new double bags, Calcutta delivery in large lots. It was, therefore, decided to arrange for trials of this fertilizer. At Mr. Sayer's instance, the Secretary, Bihar Planters' Association, Motihari, took up the matter and moved several growers to give a trial to this manure, and on their agreeing to do so an order was placed with the firm by the Secretary, Bihar Planters' Association, for May (1926) delivery of the sulfurophosphate.

The use of sulphate of ammonia and nitrate of soda is increasing in these parts, and the British Sulphate of Ammonia Federation, Ltd., informed the Secretary, Sugar Bureau, in February 1926, that they had decided to open shortly a dépôt at Muzaffarpur to meet the convenience of small cane growers in North Bihar. It is also encouraging to note that one of the sugar factories in this tract has made a move in the direction of demonstrating the benefits following from the application of these fertilizers on the cane fields of the ryots who have entered into contracts to sell their cane to the factory. As the crop in these parts does not receive at the hands of ryots any manurial treatment worthy of the name, applica-

tion of from 1 to 2 cwt. of NaNO_3 or $(\text{NH}_4)_2\text{SO}_4$ per acre at the break of the rains after the crop is ridged up is expected to show good results. If the ryots are convinced that it pays them to manure the crop in this way, and if arrangements are made to supply the manure as an advance to be recouped at the time the cane is brought to the mill like any other advance, the present miserable yields of cane will not fail to show improvement.

Other experiments undertaken by the Bureau were to find out the optimum distance between one cane row and another (2 ft., $2\frac{1}{2}$ ft., 3 ft., $3\frac{1}{2}$ ft., or 4 ft.), and to ascertain which way of placing the sets in the furrow—whether end to end, eye to eye or 6 inches apart—gives the best results. But as the land on which they were conducted was not uniform, the experiments had to be scrapped. It was, however, observed that for canes of the thickness of Co. 213, any distance less than 3 ft. between the rows was not likely to give good results. For Co. 214 which is a thinner cane the distance can be reduced to $2\frac{1}{2}$ ft. with advantage. But any reduction beyond this is to be deprecated, as it will not allow of intercultural operations to be carried out with ease, and where cane is grown without irrigation it is essential that the surface soil be constantly stirred to prevent rapid evaporation of soil moisture. For canes having long internodes, it is recommended that the sets be planted eye to eye, as this ensures a crop with as few blanks as possible, resulting in an increased yield.

Mention was made in last year's report of the experiments to plant cane at different times of the year. The usual time for planting cane in these parts is February. By the time the germination of February-planted cane has taken place, the borers emerge from their resting stage and do a lot of damage to the young shoots. But if the canes are planted in October as soon after the rains as possible, germination will take place when the borers are hibernating, and so there is every chance that the crop may escape the damage on any large scale from these insects, as by the time the moths emerge in the Spring the crop will have established itself. If this proves actually to be the case, October-planting will

be of great benefit to the growers in Bihar. The problem is, therefore, being studied in collaboration with the Entomological Section. Another advantage likely to ensue from the change in planting time is increased tonnage of the crop as a result of the longer growing period thus provided. This will be seen from the following figures of outturn per acre obtained during the year.

Variety	October planted	February planted
	Mds.	Mds.
Co. 205	781	629
Co. 213	566	382
Co. 210	520	475

Cane planted in October also seems to ripen earlier than that planted in February, as the following analysis carried out on 19th December, 1925, by the Imperial Agricultural Chemist will show :—

	IN JUICE			
	Brix (Corrected)	Sucrose	Glucose	Purity
		Per cent.	Per cent.	
Co. 213 February planted .	17.34	15.05	0.93	86.77
Co. 213 October planted .	17.66	15.93	0.69	90.21
Co. 205 February planted .	17.21	14.13	1.16	82.12
Co. 205 October planted .	16.98	14.44	0.87	85.03

In view of these promising results, the experiment is being continued. Some of the growers in Bihar have, however, already taken up this practice.

It may here be added that planting in January has so far shown no superiority in any respect over February planting.

Work done in connection with approved varieties and seed distribution. With the help of the funds placed at the disposal

of the Secretary, Sugar Bureau, by the Indian Sugar Producers' Association, nearly 31 acres were planted with Co. 210, Co. 213, Co. 214 and Co. 232. These canes had to be planted in a field which was very uneven and had extremely light soil in some portions and required a lot of levelling as it was previously badly cut up. It was green-manured with *sanai* (*Crotalaria juncea*) in the previous monsoon and received castor-cake manure at the rate of a quarter ton per acre at planting time and an equal amount at the time of ridging up. The season was on the whole normal with a precipitation of 49.78 inches from January to December distributed as under :—

January 0.66, April 1.35, May 1.20, June 4.97, July 9.10,
August 15.78, September 16.38, October 0.17, and
November 0.17.

The yields were poor as the land proved to be quite unsuited for cane. This will be seen from the figures given below :—

Time of sowing	Co. 210		Co. 213		Co. 214		Co. 232	
	Area in acres	Average yield per acre	Area in acres	Average yield per acre	Area in acres	Average yield per acre	Area in acres	Average yield per acre
January planted .	..	..	..	..	1.00	437	2.00	311
February planted .	4.19	475	6.82	386	..	..	..	..
October planted .	0.10	520	2.63	566	..	..	..	..
Ratoon .	10.00	207	4.20	184	..	..	..	..
TOTAL.	14.29	..	13.65	..	1.00	..	2.00	..

Co. 232 is very susceptible to mosaic and its yield is also not high. It has now been definitely rejected. Of the remaining three varieties, Co. 214 has a crooked habit and a comparatively lower tonnage, but it is the hardiest of the three and is comparatively disease-free, though the top shoot borer does it a certain amount of damage. Co. 214 has been found to thrive fairly well even on *usar* soils. It is the earliest ripening variety, and an important group of factories having found it reasonably satisfactory from the sugar making point of view have already taken steps to encourage its cultivation by offering a premium.

Co. 210 does well in light lands and also has been successful in heavy lands which flood to a certain degree. Most growers keep it as a reserve against Co. 213 going out and some actually prefer it. In Saran it is becoming more popular than Co. 213. It has been so far found less susceptible to mosaic than Co. 213.

Co. 213 is the heaviest tonnage cane of all the three varieties. But it requires strong land, more water and good manurial treatment. Where it has been properly grown, the yields have been excellent, and its behaviour under improved conditions of manuring and irrigation on the Dowlatpore estate shows what a fine cane it is. It is, however, liable to attacks of smut and mosaic. The damage done is so far insignificant but it requires close watching.

Out of the crop harvested, about 1,500 maunds seed-cane was distributed in Bihar and Orissa. This is exclusive of 1,000 maunds cane supplied from the farm crop to the Manager of the Bhicanpore Concern for planting.

Seed-cane in small lots was also supplied to officers and private individuals mentioned below :—

- (1) Agricultural Chemist to the Government of Bengal, Dacca—Co. 275.
- (2) G. Hutton, Esq., Kalimpong, Bengal—Co. 213.
- (3) Padrauna Sugar Works, Padrauna, Gorakhpore, United Provinces—Co. 213.
- (4) T. N. Dhar, Esq., Estate Manager, Alinagar, Bahraich, United Provinces—Co. 205.
- (5) Deputy Director of Agriculture, Jubbulpore, Central Provinces—Co. 210 and Co. 213.
- (6) Deputy Director of Agriculture, Southern Circle, Nagpur, Central Provinces—Co. 210.
- (7) Nira Valley Sugar Works, Baramati, Bombay Presidency—Co. 210 and Co. 213.
- (8) Belapur Company, Limited, Harigaon, Ahmednagar, Bombay Presidency—Co. 210 and Co. 213.
- (9) Deputy Director of Agriculture, Surat, Gujarat, Bombay Presidency—Co. 205.

(10) C. A. Wood, Esq., Aurangabad, Deccan—Co. 210 and Co. 213.

Besides, a few sets of Co. 205, Co. 210, Co. 213, Co. 214 and Co. 281 were sent overseas to the Director, Natal Sugar Experiment Station (South African Sugar Association) for trial.

Mosaic. During the year under report, mosaic on Coimbatore canes and in the local variety Hemja was definitely established; so far only mottling of the leaves has been noticed. The disease is now under investigation by the Imperial Mycologist as to how it is propagated in India and what effect it has on the yield of cane. The varieties Co. 205, 213, 250, 273, 275, 280, 281, 286 and 290 have been planted with healthy seed, and each of them has been interstripped with a row of Co. 232 planted with mosaic-affected sets to find out how far the new crop is affected with mosaic and how the secondary infection spreads from diseased cane nearby to a healthy crop.

To test the effects on yield, an acre plot has been laid down, the half of which has been sown with diseased sets and the other half with healthy material. The present indications are that planting diseased sets does produce diseased canes.

At present the measures being taken are the rogueing out of affected clumps as soon as they are detected and planting sets from only healthy canes. This work is being done in collaboration with the Mycological Section.

It was mentioned in last year's report that the Government of Bihar and Orissa had placed four Overseers of their department under the Secretary, Sugar Bureau, for training in improved methods of cane growing and for propaganda work in the districts. The scheme worked admirably, and considerable assistance was rendered through them to the cane growers in demonstrating improved methods of cultivation, manuring, detection of disease and the prompt measures to be taken to prevent its further spread. They visited some 36 Concerns and examined an area of some 1,600 acres in over 100 villages during the year under review.

II. INDUSTRIAL.

As in previous years, the Bureau continued to be in touch with the sugar factories in India and furnished such information as was likely to be useful to them. The factories on their part fully reciprocated by furnishing the Bureau with such information as was asked for, in the matter of cane supplies and chemical control in the factory. The returns for the working season 1924-25 were obtained from all factories and refineries in India, and a consolidated statement of total sugar production in India was compiled and published in the "Indian Trade Journal" and the "Agricultural Journal of India." During the year under report the sugar factory at Sahmaw in Upper Burma was completed and a trial run was arranged. It is hoped the factory will begin its operations next year. Four refineries started working for the first time this year. The names of these are as under :—(1) Sitamarhi Sugar Works, Siwan ; (2) Lucknow Sugar Works, Lucknow ; (3) Jhusi Sugar Works, Jhusi (Allahabad) ; (4) Amritsar Sugar Mills, Amritsar,

It should, however, be mentioned that refining *gur* in these days of low prices of sugar is not likely to be a paying business, and it would be well if more factories making sugar direct from cane were established in future.

But for low prices ruling for sugar throughout the year, the season 1925-26 was not an unfavourable one. The sugar-cane crop in the white sugar tract was the heaviest during the last five years. The area under cane in India was also 116,000 acres more than in the previous season. Most of the factories, therefore, obtained sufficient supplies of cane for crushing. The sucrose content of these canes was also fairly good and the recovery of sugar was higher than last year.

As a result of greatly increased production of cane sugar in Cuba and Java and of beet sugar in Europe, the supplies were considerably in excess of the world's requirements. The consequence was that the prices for this commodity remained at a low level. As the price of factory-made sugar in India is governed by the price of Java white sugar landed at Calcutta, Indian factory-made sugars also fetched low prices. The industry is thus passing through a critical period. The problem

of the improvement of the Indian sugar industry is dependent on—

- (1) The availability at fair prices of increased supplies of good quality cane at a reasonable distance from the factory, which can be arranged by growing improved varieties under intensive methods of cultivation.
- (2) Efficiency in factory working.

In this connection, I would repeat what Mr. Sayer said last year :—“ Efficiency in the field, efficiency in the factory and efficiency all round in organization, this and this alone will enable the sugar industry in India to stand in competition against imported sugar. The Government by fixing a specific duty of Rs. 4-8 per cwt. on imported white sugar have given indirect protection to the local industry, but this alone will not solve the problem. The factories must take more and more interest in the ryots growing the cane which the factory crushes, and should assist the Agricultural Department in its efforts to popularize improved varieties and distribution of oil-cake and other nitrogenous manures.”

The Bureau continued to maintain a list of candidates seeking employment in factories and refineries, and the names of suitable persons from among them were brought to the notice of factories when the services of such men were required. This line of work is appreciated both by the industry and the persons who are seeking employment in the sugar line.

It is interesting to note that three factories increased their capacity during the year under report. It is also pleasing to note that better qualified chemists or chemical assistants and men with technological experience are more and more in request, and if the supplies of cane increase in the districts where these factories are situated, which is quite possible without bringing any new area under cane, if more extended efforts are made by the Agricultural and Co-operative Departments in conjunction with the factories to improve the standard of cane cultivation in these parts, the condition of the industry would be better than what it is at present. It is sad to see that while in other countries the growers are keen on taking

up any improvement which may be demonstrated on an experiment station, here a large amount of energy has to be expended in inducing the ryots to adopt the improvements.

III. COMMERCIAL AND STATISTICAL.

The Bureau continued to obtain during the year the price quotations for various grades of *gur* from important *gur* markets in India and to forward them to the Director-General, Commercial Intelligence, Calcutta, for publication in the "Indian Trade Journal." Besides this, the Commercial Intelligence Department was regularly supplied every week with the quotations for Java white sugar at Soerabaya, Java, and for Cawnpore-special sugar at Cawnpore. Figures of stocks of sugar in the principal ports in India were also communicated to the same department for publication in each issue of the "Indian Trade Journal."

The Bureau furnished a brief note on the condition and prospects of the sugar crop in the principal cane-growing countries of the world for inclusion in the first, second and third Indian sugarcane crop forecasts issued by the Commercial Intelligence Department, while notes giving statistical information regarding the production, exports, consumption, stocks, etc., likely to be useful to the sugar trade in India were regularly published in the "Indian Trade Journal." The number of such notes published during the year amounted to 36.

The Sugar Cable Service started in 1922 was continued during the year. The subscriptions realized were sufficient to run the service on a self-supporting basis. The utility of the service was further enhanced by securing during the year the services of two more agents in London and Semarang. The telegrams and weekly reviews supplied by the Bureau kept the merchants in India fully posted with the world's sugar market conditions and fluctuations in prices. The importance of this service can be gauged from the fact that the Cuban Government are considering the formation of a Sugar Information Bureau at a very early date to enable the Colonos to be kept informed of the latest developments in the world's markets. In India, the service is of

the greatest importance especially to those importers who in the usual course cannot obtain for themselves direct, all the information supplied from the Bureau unless at a greatly increased cost.

IV. MISCELLANEOUS.

Library. During the year under review 306 volumes were added to the Library by way of purchase, exchange or free supply and by binding loose copies of the periodicals received in the library. In spite of the fact that private individuals outside Pusa are required to deposit the full value of the books or publications taken by them on loan, it is satisfactory to note that use is being made of the library by those interested in the sugar line.

Museum. As usual, old samples of sugar were replaced by fresh ones obtained from sugar factories and refineries in India and were duly exhibited in the museum. No samples of foreign sugar were received during the year. Samples of *deshi* sugar manufactured in India were obtained from Messrs. Begg, Sutherland & Co. and forwarded to Messrs. Fraser, Eaton & Co., Soerabaya, as required by them. The samples of *gur* were also renewed during the year under report and much useful information obtained as regards the price and quality of *gur* produced in different districts in India. A good use of this museum is now being made by visitors and students.

Publications. Besides the 36 notes contributed to the "Indian Trade Journal," Mr. Sayer published a Review of the Sugar Trade in India during 1924-25 as a supplement to the same Journal. Four notes were also published in the "Agricultural Journal of India." Besides these, an article on "Improved methods of cane cultivation in North Bihar" under the joint authorship of Mr. Sayer, the present writer, and Mr. Hardayal Singh, Recorder, Sugar Bureau, was written up during the year under report and sent for final approval to Mr. Sayer at Home. Another article on the world's sugar supplies by the present writer and Mr. Dhirajlal M. Desai, Recorder, Sugar Bureau, was completed during the year.

V. CONCLUSION.

During the five years 1921-22 to 1925-26 the Sugar Bureau selected and grew on a field scale nine Coimbatore seedlings (Nos. 205, 210, 213, 214, 221, 232, 233, 275 and 280) out of 58 received for trial, arranged for factory tests of five of them and on their results rejected two; *viz.*, 232 and 233, and took steps to establish Nos. 210, 213 and 214 not only in Bihar but also in other parts of India by distributing over 61,000 maunds of seed-cane. It is now subjecting to further field tests Co. 275 and 280, while Co. 205 is being given out for low-lying lands. A very promising new variety at present is Co. 290 which, as mentioned above, is not only vigorous in growth but has so far shown remarkable powers of resistance to mosaic. It will thus be seen that the Bureau is taking steps to keep itself well stocked with suitable new varieties to replace the ones already given out if they show signs of degeneration. Hitherto this work of growing improved canes on a field scale used to be done with the financial help given by private bodies interested in the improvement of the Indian sugarcane industry, and our most grateful acknowledgments are due to them for the assistance they have rendered, as otherwise it would have been impossible to do this work on a large scale at Pusa owing to the financial stringency from which the Government of India suffered in the earlier part of the quinquennium. Acknowledgments are also due to the various officers of the Institute, including the Government Sugarcane Expert, who have so readily given advice and assistance whenever asked for. In conclusion, it may be mentioned that if it were not for these improved canes with their higher yield and the specific duty of Rs. 4-8 per cwt. on imported white sugar, the position of the factory industry in the white sugar tract would have become much more unsatisfactory than it is at present. It is being increasingly realized that without more research and propaganda work devoted to cane and without an import duty maintained at its present, if not a higher, level, the industry cannot hope to keep its head above water in an era of low prices.

REPORT ON EXPERIMENTS WITH *CAJANUS INDICUS* (*RAHAR*) FOR RESISTANCE TO *FUSARIUM VASINFECTUM* (WILT DISEASE).

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Progress was made with the investigation which has for its object the isolation of a race of *rahar* resistant to the wilt disease. The seed which was selected in 1924, as described in the last annual reports of the Imperial Mycologist and the Imperial Economic Botanist, was sown in lines alternating with lines sown with seed of a type known to be susceptible to the disease. Each line of the selected seed was from a single "resistant" plant which had been bagged in the previous season. There were in all 24 selections, 17 of which were descended from one parent and 7 from another; these two progenies were lettered "A" and "B" respectively. When the plants were about one foot high, the field was artificially infected by planting between the plants pieces of diseased *rahar* stem kept from the previous year's crop. At weekly intervals throughout the season counts were made of the number of diseased plants in each line. In the "A" series there were 657 plants and the percentage of deaths due to wilt was 9, while in the lines of the susceptible variety which alternated with the "A" plants there were 693 plants and the percentage of deaths due to wilt was 66. In the "B" series the percentage of deaths in 242 plants was 54, and in the susceptible plants which alternated with them the loss was 79 per cent. in 270 plants. At the south end of the plot an unused space beyond the last line of the "B" series was occupied by 496 plants of the susceptible type; in this area there was 90 per cent. loss due to wilt disease.

These figures suggest that in the "A" series at least selection has already resulted in the accumulation of a certain amount of resistance. A comparison of the 66 per cent. of

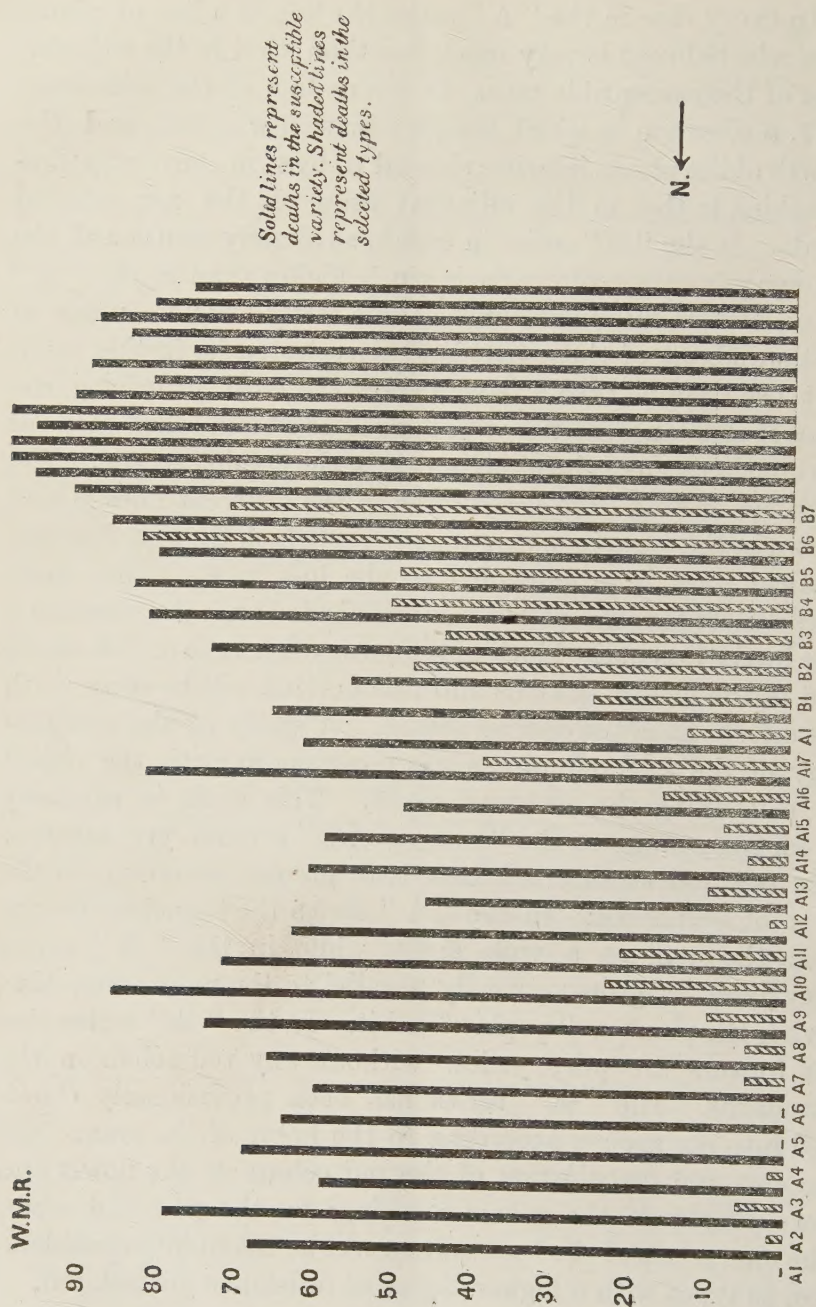
deaths in the susceptible plants which alternated with the "A" plants with the 90 per cent. of deaths in the susceptible plants at the south end of the field suggests that this end of the field is more severely infected than the northern portion. It is significant that the south end of the field is less well drained than the remaining area, and possibly affords a more favourable medium for the development of the disease. The greatest difficulty in the experiment is to obtain uniform infection over the field, and the results obtained in any one season will have to be checked by reversing the order of sowing in the succeeding season. The relatively high percentage of deaths in the "B" series might be due to the slightly increased intensity of the disease in this area of the field or to the fact that this series is not so resistant to the disease as is the "A" series. The intensity of the disease over the whole area occupied by the "A" and "B" selections appears, however, to be about the same, as is shown by the fact that the percentage of deaths in the susceptible plants which alternate with the "B" plants is very little higher than that in the susceptible plants which alternate with the "A" plants. This suggests that a distinct degree of resistance is present in the "A" plants and absent or present in a less degree in the "B" plants.

The following statement shows the percentage of deaths which occurred in each line of the selections and in each line of the susceptible variety which is denoted by "Z". There were 39 places for plants in each line. The difference between that number and the number of effective plants given in the statement is due either to non-germination of the seed or to death from causes other than wilt.

Resistance trial of rahar plants in Botanical Area, Pusa, 1925-26.

Line	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Seed	A1	Z	*A2	Z	*A3	Z	*A4	Z	*A5	Z	*A6	Z	A7	Z	A8	Z	A9	Z	A10	Z	A11
Number of effective plants	36	38	38	39	31	39	38	39	37	39	37	38	39	38	38	38	39	37	39	39	38
Number of wilted plants	0	26	1	31	2	23	1	27	0	25	0	23	2	25	2	28	4	32	9	28	8
Percentage of wilted plants	0	68	2	79	6	59	2	69	0	64	0	60	5	66	5	74	10	86	23	72	21
Line	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Seed	Z	*A12	Z	A13	Z	*A14	Z	A15	*Z	A16	Z	A17	Z	A1	Z	*B1	Z	B2	Z	B3	Z
Number of effective plants	38	39	39	38	39	39	39	38	39	37	39	18	37	38	39	39	39	29	39	72	39
Number of wilted plants	24	1	18	4	24	2	23	3	19	6	32	7	23	5	26	10	22	14	29	12	32
Percentage of wilted plants	63	2	46	10	61	5	59	8	49	16	82	39	62	13	66	25	56	48	74	44	82
Line	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
Seed	B4	Z	B5	Z	B6	Z	B7	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Number of effective plants	37	39	38	38	36	39	36	37	39	36	37	38	38	38	38	39	39	39	37	39	39
Number of wilted plants	19	33	19	31	30	34	26	34	38	36	37	37	38	35	31	35	30	33	33	32	30
Percentage of wilted plants	51	84	50	81	83	87	72	92	97	100	100	97	100	92	82	90	77	85	89	82	77

In every case in the "A" series the loss in a line of plants from selected seed is very much less than that in the adjacent lines of the susceptible race. Only one line of the selections, A 17, a selection in which the germination was bad and the growth of the plants inferior, showed a loss in any way approaching to that in the adjacent lines of the non-selected plants. In the "B" series in which, as already mentioned, the average percentage of deaths is much higher than in the "A" series, certain individual lines have a fairly low percentage of deaths and one of them (B1) has been selected for further tests. In those lines marked *, which show the most promising degrees of resistance, plants were bagged to obtain selfed seed for the continuance of the experiment in the coming season. The variation in loss from the disease in the different lines is well shown in the accompanying diagram in which the length of the vertical lines is proportional to the loss in each line, dark lines denote the susceptible race and shaded lines the selections. The heavy loss in the block of the susceptible type at the south end of the field is obvious and this portion will be sown with the selections in the coming season. A study of the morphology of the selected plants was commenced with the object of classifying the resistant types. This work is naturally in an early stage as the "unit species" are not yet isolated. The selected strains fall into two groups according to the type of branching. In the "A" series the branches diverge from the stem at a wide angle, while in the "B" series they tend to grow vertically parallel to the main stem, thus giving the plant a "poplar" habit. In the "B" series also the flowers are pure yellow without any red colour in the standards. The "A" series has been provisionally classified into six groups according to the habit of the stem, the amount and distribution of the red colour in the flower and the character of the colour markings on the pod and seeds. The characters of the root system will be taken into consideration as types with a higher degree of resistance are isolated.



PERCENTAGE OF WILTED PLANTS IN RESISTANCE TRIAL OF RAHAR PLANTS IN BOTANICAL AREA PLOT, 1925-26.